Africa Research in Sustainable Intensification for the Next Generation East and Southern Africa

Intensification of maize-legume based systems in the semi-arid areas of Tanzania to increase farm productivity and improves farming natural resource base

Project 2013 -14

This proposal is produced by: **Joanna Kane-Potaka, (ICRISAT)**
Patrick Okori, (ICRISAT)

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Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads an associated project on monitoring, evaluation and impact assessment.

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Organization: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	
Mailing Address: ICRISAT, Patancheru 502 324, Andhra Pradesh, India	Contact Person: Joanna Kane-Potaka Director, Strategic Marketing & Communication ICRISAT Patancheru 502 324 Tel: +91 40 3071 3227 Fax: +91 40 3071 3074 Email: J.Kane-Potaka@cgiar.org
Country	Tanzania – Kongwa and Kiteto Districts
Principal Investigator	Patrick Okori, Principal Scientist (Plant Breeding) ICRISAT Malawi

2b. Research Team composition

Name	Gender	Institution	Disciplinary expertise	Highest qualification	Project role	% Time
Elirehema Swai	M	ARI- Hombolo	Soil Scientist/ Agronomy	PhD	Co-PI	15
Anthony Kimaro	M	ICRAF	Forestry & Soil Fertility	PhD	Co-PI	15
Dan Makumbi	M	CIMMYT	Plant Breeder		Co-PI	15
Ganga-Rao, NVPR	M	ICRISAT	Plant Breeder	PhD	Co-PI	15
Anitha Seetha	F	ICRISAT	Molecular Diagnosis	PhD	Scientist	5
Omari Mponda	M	ARI Nalendele	Plant Breeder	PhD	Scientist	5
Chrispinus Rubanza	M	University of Dodoma	Forage Scientist	PhD	Scientist	5
Rashid Msangi	M	Pasture Research	Forage Scientist	PhD	Scientist	5
Martha Swamila	F	ICRAF	Agriculture Economist	M.Sc.	Scientific Assistant	5
Mathew Mpanda	M	ICRAF	Forestry/Nursery techniques	M.Sc.	Associate Researcher	5

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1 Abstract for The Research Project

The aim of this project, now in the second year of implementation, is to provide a scientific basis for sustainably intensifying agricultural production in semi-arid areas of central Tanzania. The project will implement **6** work packages that address three critical elements of sustainable intensification, i.e. genetic, ecological and socio-economic components. The scope of activities being implemented include: introduction and testing of integrated legume/cereals technologies; food safety primarily to reduce aflatoxin contamination and integration of livestock into the cropping systems. In the 2012-2013 season, we reached out to about 500 farmers, whilst in the 2013-2014 season we will reach out to about 700 farmers in the two districts. Innovation platforms will be established at site level to inform R4D priority, processed and impact pathways. The project team remains the same with ICRISAT leading implementation. The total budget for this year is **760,000** USD.

2 Research Problem and Justification

This project was launched in the 2012-2013 cropping season to improve resilience and productivity of maize-legume based farming systems in the semi-arid districts of Kongwa and Kiteto in Manyara and Dodoma regions of Tanzania. Our research strategy is underpinned by four major limitations to increased productivity in semi-arid zones of Tanzania.

1. Low productivity of crops and livestock sub sectors.
2. Fragile production to market systems unable to sustain high levels of crops and livestock production.
3. High vulnerability of communities to weather and other natural disaster related challenges as well as being are nutritionally the most deficient (IFAD[1], 2001).
4. High levels of poverty, with Dodoma region having one of the highest proportions of people living below the food poverty line at 35.5% and up to 51.4% based on expenditures[2].

Last year, this research for development (R4D) team undertook activities to generate approaches for sustainably intensifying agricultural productivity of agro-pastoral communities in Kongwa and Kiteto.

Box 1: Main results from year 2012-13

1. **Major yield gap.** In the target regions, maize and sorghum are the staple cereals with a yield gap of over 50%. Cereal yields in Kongwa are relatively higher than Kiteto (782.3 kg/ha- maize and 323.5kg/ha- sorghum) and Kiteto (623.4kg/ha- maize and 207.2kg/ha)[1.] The yield gap for the legumes is 30% - groundnuts 608.9kg/ha and 200.3 kg/ha- pigeonpea and in Kiteto groundnut yield was 450.8 kg /ha and pigeon pea 117.3 kg/ha.
2. **Adaptability of cereals and legumes.** Using participatory variety selection we identified 2 crop genotypes each of groundnuts (Mnange-0.8T/ha and ICGV-SM ICGV-SM 02724-1.5T/ha) and Pigeonpea- ICEAP0557, ICEAP 554).
3. **Integrated soil fertility management**. Fertilizer trials revealed that optimum P rate for maize is 30 kg P ha^{-1} although applications of 15 kg P ha^{-1} don't lead to yield loss. The micro-dose P application rate could provide farmers with inorganic fertilizer-based intensification options. Maize response to N fertilizer was poor, suggesting other limiting factors.
4. **Improving soil moisture**. *In situ* water harvesting technologies such as the ox-ripper and ox-ridger tillage increased grain yield by 25% % and 30 % respectively. They will be further tested in 2014.
5. **Nutrition, food safety and security.** The most food insecure period is February to April during which Bambara nut is the main source of protein and sorghum for energy. Targeted cereals and legumes had very high levels of aflatoxin (>20ppb) and communities didn't use appropriate management options at household level.
6. **Crop-livestock interaction.** The supply of quality feeds and herbage (1.6 t DM/ha for Kiteto and 1.83 t DM/ha in Kongwa); low quality feed resources (limited nitrogen or crude protein) and limited

IFAD, 2001. Rural Poverty in Tanzania. International Fund for Agricultural Development.

2 Mkenda, A.F., Luvanda, E.G., Rutasitara, L. and Naho, A. 2004. Poverty in Tanzania: Comparisons across administrative regions. Interim report.

Highlights of progress that form the basis for year two work are summarized in box 1.
Work on characterization of rangelands for biomass and nutritive values have been initiated to underpin livestock intensification efforts. The past year's results show that there is scope: (i) to find novel crop varieties that will enhance production (ii) to improve soil productivity if key debilitating factors are elucidated (iii) for expansion of cereal crops given that, maize production is very water stressed in some areas, and; (iv) addressing aflatoxin contamination which is a major threat to food safety; and address nutrition outcomes by inclusion of vegetables. In order to ensure lesson learning and effective adoption, the project is being implemented in manner that ensures testing, validation of technologies and adoption strategies (hypothesis 4 of Africa RISING) for intensification purposes (Figure 1). These issues will be investigated in year three and four in an integrated and incremental manner. Livestock R4D activities will be increased after rangeland characterization.

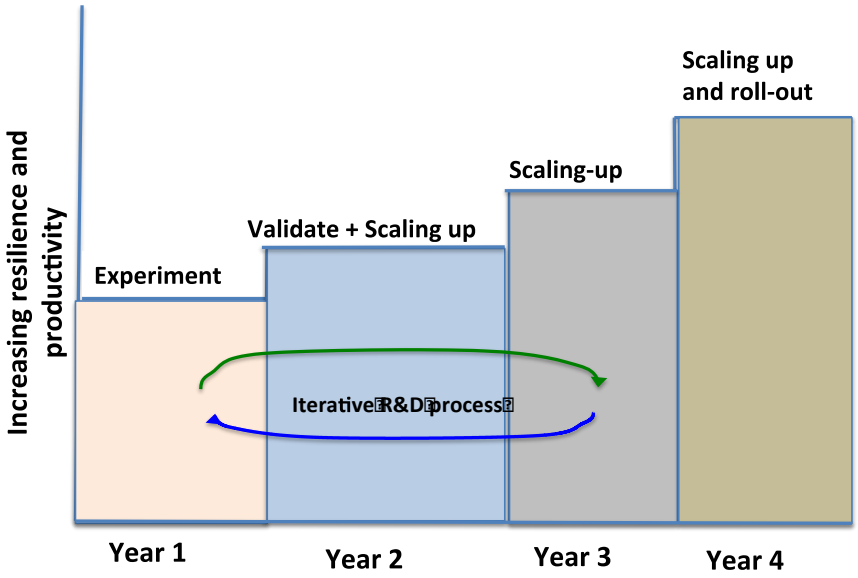


Figure 1. Conceptual diagram illustrating the project implementation framework being used to ensure lesson learning integration and effective adoption for sustainable intensification are well planned in line with Hypothesis 4 of the Programme Framework.

3 Relevance of Proposal to Africa RISING Framework

This project has been designed along the Africa RISING principles of; (i) targeting investments and activities at the farm household scale inline with farm typology differences, (ii) Applying innovations that sustainably increase output from the same land area, while reducing negative environmental impacts, increasing contributions to natural capital and the flow of environmental services; and (iii) evaluating different options of innovations to generate options for intensification in semi-arid zones, (iv) location and design of interventions to identify and test key elements of development domains for the target districts and (v) engaging various R&D partners in innovation to improve relevance and adoption. Using these principles, our project is designed to experiment/ evaluate diverse options for sustainable intensification of crop and livestock productivity in Kongwa and Kiteto. This is followed by targeted evaluation of promising innovations using community R&D participatory approaches, and ultimately scaling-up and -out of candidate innovations. An integrated approach involving diverse R&D specialties is being used to generate a suite of technologies relevant for semi-arid zones. We are also investigating options for soil and water management that sits well with the agro-pastoral communities based on dryland cereals (adapted maize and pearl millet) and legumes (pigeon pea and groundnuts) to improve both energy and protein nutrient demands of communities. This also includes dietary supplements cheaply available from a partner Tuboreshe Chakula. Improving access to markets through partnerships with NAFAKA will contribute to income improvement. In order to underpin all innovation processes we will form this year on establish R4D

platforms in each district. This way, our R4D approach will thus evaluate the Africa RISING approach and provide key lessons for semi arid savannahs of Tanzania.

4 Research Objectives

In year two of the project, the plan is to ensure that objectives related to increasing production and productivity of crops and livestock are mutually reinforcing and supported by cross cutting socio-institutional issues that influence technology adoption. All objectives have been designed based on key results obtained in year one of the project. Objectives that require landscape-wide interactions will implemented at pilot and landscape scales; (particularly for erosion management, and grazing land management issues), to ensure effectiveness of intervention and learning of potential impacts of interventions. The entire project is testing Africa Rising Framework R&D hypothesis 4. However, project objectives 1-4 are also testing programme hypothesis 2 on integration, while objective 5 is testing Programme hypothesis 1 with an RO2 focus. A brief description of each project objective is provided below.

1. **Introduce and evaluate improved varieties of maize for reaction to maize leaf necrosis as well as adaptability for grain legumes.** In order to close the yield gap there is need to introduce adaptive material with high genetic potential and good stress tolerance but that "fit" the production and end-use demand needs. In 2013-2014, we will further evaluate, validate and disseminate adapted and demand responsive high yielding material identified in year 1 as the best performers (groundnuts, pigeon pea and maize) to improve productivity and close the yield gap of the these food, nutrition and income security crops (Box 1). Maize varieties will also be evaluated for their response to MLN disease, and surveys will be conducted to establish the prevalence of the disease in Kongwa and Kiteto. This output will contribute to outcome 1 of our intervention (increased crop productivity) and objective 1 of the Africa RISING Programme.
2. **Evaluate integrated soil fertility and water management options to improve plant nutrition, yield of crops and enhance agro-ecosystem resilience in action areas**. In order to validate and implement sustainable agricultural resource management and offer nutritional and marketing advantages we will further test options for management of soil fertility in these environments by integrating promising fertility applications and cereal legume/crop management options identified in year of experimentation (Box 1). This output will contribute to objective 2 of the Africa RISING programme. This year, soil fertility management will be integrated with *in situ* water management techniques in communities based on results of year 1. This process will be done to increase production, conserve natural resources, reduce or stop soil erosion and degradation of soil and foster agricultural plant biodiversity. This activity will contribute to objective 2 and 3 of Africa RISING programme.
3. **Integration of crops, livestock and poultry for enhanced productivity and resilience.** In year 2, the objective will test options for improving livestock productivity through enhancing rangeland (grazing land) management to improve quality and quantity of pasture. In year 1, we assessed the pasture quality during the dry season and this year we will assess pasture quality, quantity and feed resources in the wet season to generate the feed availability calendar and support development of efficient management systems. We will further study the role of social structures as guided by our year 1 studies which show differences in grazing land management. Comparisons between managed grazing systems in Kongwa and free-range community based systems (*Alalili*) management in Kiteto. This objective will contribute to objective 2 and 3 of the programme.
4. **Improving nutrition, safety and market competitiveness through post-harvest handling and utilization.** This objective will contribute to improving household food and nutrition

security among households especially women and children. We will deploy aflatoxin management technologies to mitigate the effects of contamination as well as build capacity of regional partners to detect and contribute to management of mycotoxins (Box 1 for highlights of year 1 results). Special effort will be made to support women farmers as technical innovators, resource managers and homemakers through training and targeted engagement in R&D processes. This objective will contribute to objective 2 of Africa RISING.

5. **Establish Innovation Platform to inform R4D**. This objective will explore opportunities for deepening our understanding of output 2 of Africa RISING. Two Innovation Platform one aimed at improving functionality of selected value chains and the second on improving delivery of nutrition outcomes will be established at sites. The Innovation Platforms will elucidate socioeconomic contexts of innovation process, challenges to value functionality and technology adoption issues in target communities. These innovation Platforms will inform WP's 1-4.

5 Methodology

This year all activities have been designed to validate and or underpin integration and scaling up and out of scaling. We will still address the three key elements of sustainable intensification i.e. ecological, genetic and sociological intensification[3]. Work package 1 aims at assuring genetic intensification through provision of highly resilient and productive crop varieties; Work packages (2, 3 and 4) addressing ecological intensification by harnessing intercropping and crop-tree livestock and water management systems to conserve water and soils, increase mutual benefits between crops livestock and the other components of the ecosystem Work package 4 is dependent on benefits of genetic intensification needed for sociological intensification by increasing availability of safe-food for household and wider markets needs. All WPs are being implemented to assure mutual benefits to all components of the project.

5.1 Work package 1.

Work package number	**WP 1**	**Event period:**			October 2013 to September 2014	
Work package title	On-farm evaluation of improved legumes and cereals; & MLN disease management, for SI integration					
Activity Type	Action research, capacity building for farmers and extension staff					
Target areas (Districts- Villages)	Kongwa-Chitego	Kongwa-Laikala		Kongwa-Mlali	Kongwa-Moleti	Kiteto-Njoro
WP leader	ICRISAT					
Partners	ARI-Hombolo	NAFAKA	CIMMYT	AVRDC	ARI-Naliendele	ARI-Selian
WP budget	**128,680**					

Relevant Africa RISING Research Output (RO2): Integrated systems improvement
Key intervention areas: The yield gap for selected crops based on our year 1 results show that on average farmers are getting less than 50% of potential yield. During the 2013/2014 season, we will conduct two forms of R4D aimed at reducing the yield gap. The focus of this activity will be genetic intensification that will ultimately strengthen ecological intensification efforts. The first R4D will constitute validation of varieties (cereals and legumes) to provide a robust understanding of adaptation potential for new materials targeted for the semi-arid agro-ecologies. These materials will also underpin initial integration with other WPs. We will also conduct a second cycle of participatory variety selection (PVS) to validate the last year farmer-selected material for wider

[3] The Montpellier Panel, 2013. Sustainable Intensification: A New Paradigm for African Agriculture. London: Agriculture for Impact.

adoption, variety release and or promotion (Appendix 1). In the second R4D, we will initiate a participatory variety selection for new crops (Bambara nuts and sorghum) following observations from our project base line study conducted in year one of experimentation that show that these crops are central to the farming systems of the target areas. The PVS will contribute to selection of the most adapted varieties as well as subsequent release of new varieties. No new Bambara nuts have been released in Tanzania recently. Most farmers in these districts grow low potential genotypes[4] and new varieties could be harnessed to increase productivity. Thus PVS will still be conducted in a manner that complements farm enterprises. Overall these new materials and old are being harnessed as a key driver for intensification because crop genetic potential invariably influences yield and productivity.

Description of work

Research questions/hypotheses

Farmers in the semi arid zones of central Tanzania have an understanding of agro-ecological needs of their region and can therefore select the best crop varieties suitable cropping and farming systems.

Task 1.1. Cereal experiments

The first task is the selection of experimental sites that will be arranged using the mother baby trial approach. Farmers (at least 60% women) willing to provide land for PVS trials, large scale demonstrations and community based seed production will be selected with help of village extension officers, village leadership, NAFAKA, DAICOs and ARI Hombolo. Care will be taken to capture the most common farm typologies in these districts as baby experimental sites. Gender dimensions affecting adoption of new varieties and use of new varieties will be elucidated.

Subtask 1.1.1. Maize. Two main activities will be undertaken.

1. Reaction to maize leaf necrosis and general adaptability. The first activity will evaluate the performance of stress tolerant maize varieties under farmer field conditions for adaptation and reaction to Maize Leaf Necrosis (MLN) a new threat to maize production. The new materials being tested have shown tolerance to MLN under artificial and natural infestation in Kenya. However to rule out location variability in disease reactions, studies will be conducted in Babati, Kongwa and Kiteto. Surveillance data will also be assembled on prevalence and severity of MLN to guide disease management. Results from Babati for the 2012- 2013 season, show that most introduced material did not perform as well as the locally adapted material. However to validate these results for Kiteto and Kongwa, we will conduct further evaluations, on six new early and intermediate maturity drought tolerant and two locally available maize varieties using a mother-baby trial approach. The mother trial comprising (8 varieties) will be established at 10 locations, with at least 5 in each district (Kongwa and Kiteto). Each mother trial will have at least 4 baby trials with not more than 4 farmer-selected varieties to give a minimum of total of 20 baby trials each district. The mother trials will be researcher managed, while the baby trials will be farmer managed. Data on yield and farmer preference for production qualities and use will be collected and used to inform adoption strategies.

2. Quality Protein Maize (QPM) Variety Demonstration. Our baselines conducted in 2013 show cereals as the major source of dietary energy with maize being a major crop. In these dry lands, overall, per capita cereal consumption is low in nutrients[5] at 156 kg compared to the national

[4] Mponda. O. Programme Leader Grain Legumes. Naliendele Agricultural Research Station, Mtwara. Tanzania. Personal communication.

[5] Morris, M., Butterworth, J., Lamboll, R., Lazaro, E., Maganga, F. and Marsland, N. 2006. Household Livelihood Strategies in Semi-Arid Tanzania: Synthesis of Findings. Natural Resources Institute in collaboration with department of agricultural economics & agribusiness Sokoine University of Agriculture and the Institute of Resource Assessment University of Dar es Salaam. An annex to the Natural Resources Systems Programme Final Technical Report for research project R7805 funded by the UK Department for International Development (DFID).

average of 325 kg. Improving nutrient density using QPM has been used to address dietary concerns of maize dependent communities[6]. QPM varieties have been released in Tanzania. However, farmers in the target area have not been exposed to these varieties. Due to late arrival of seed in year 1 this part of the study was not done yet it is critical for nutrition outcomes of the project. Thus an initial adaptability trial conducted on the suitability of these genotypes for the semi-arid zones of Tanzania as an initial step. These genotypes will also be included in the soils nutrient studies of objective 2. The three released varieties (Lishe K1, Lishe H1 and TANH611), five experimental hybrids and one farmer preferred variety will be planted in on-farm demo plots at five (5) locations. The plot sizes will be 10 m x 10 m. Farmer assessment of the varieties will be carried out at harvest. Pairwise comparisons of introduced versus farmer adapted material will be done to infer farmer preference. Data on yield and farmer preferences for production qualities and use will be collected and used to inform adoption strategies.

Sub-task 1.1.2. Sorghum. During the 2012-2013 cropping season we observed that in Laikala, and Moleti maize was not the most suitable cereal. Our baseline studies show that indeed more drought hardy cereals such as pearl millet and sorghum are cultivated. Following consultations within the project team and with district officials, we propose to evaluate the performance of stress tolerant sorghum varieties under farmer field conditions for adaptation. 3-6 high yielding sorghum varieties will be evaluated at Laikala, Mlali and Moleti villages using PVS approach. Data analysis of PVS will be done as described in 1.1.1. The analysed data on yield and farmer preferences will be used to inform adoption strategies, soil fertility trials and plan for community based seed production and promotion in subsequent years.

Task 1. 2. **Description of legume experiments**

Sub-task 1.2.1 Pigeonpea. In year 1 (2012-2013) using participatory variety selection (PVS) we identified two pigeonpea genotypes ICEAPs 00554 and 00557 as the highest yielding and most preferred material by farmers in Kongwa and Kiteto. WP 2 will use these varieties for integration purposes. However due to late planting of the crop in 2012, there is need to further validate performance of top performers. Thus two top performing genotypes along with an additional 3-5 medium and long duration pigeonpea varieties will be evaluated using PVS in five villages of both districts. Introduction of long duration material is being brought in because they in general yield more grain and biomass that can be supply both feed and soil organic matter. Pairwise comparisons of the entries (new and farmer adapted) will be done. Best performing material from 2012-2013 will be included in objective 2 on integrated soil fertility management. Data will be collected and used to inform adoption and promotion strategies for the improved pigeonpea varieties. Strategic partnerships with NAFAKA farmers will be used to manage on-farm demonstrations. Due to high pest incidences on pigeonpea, a farmer and extension training on integrated crop management practices such as pest management and quality seed production will be done to complement research efforts.

Sub-task 1.2.2. Groundnuts. The best performers from the first cycle of PVS will be used in WP2 as well as within this work package to evaluate different production systems such as double-up legume production. Given that the late planting of the crop may have influenced full potential in 2012-2-13 season, we will further evaluate the performance of farmer selected improved groundnut varieties under wider farmer field conditions for adaptation (yield, resilience to rosette and drought and farmer preference etc.). Due to complexities associated with seed delivery systems for grain legumes, especially groundnuts, we will investigate adoption requirements for groundnut in these dry land agro-ecologies. For this purpose, the two best performers (Mnanje and ICGV-SM 02724) identified in year 1 will be used to study adoption requirements for groundnuts based seed-systems

[6] Ouma, J.O., Bett, C. and Githaigah, T. 2010. Market Access, Approaches and Opportunities for QPM based products. Paper presented during the Joint 3rd African Association of Agricultural Economists and 48th Agricultural Economists Association of South Africa Conference, Cape Town, South Africa, September 19-23, 2010.

in 3 villages (Njoro, Moleti and Mlali). We will also evaluate 3 new varieties using participatory variety selection approaches. All evaluation experiments will be established at mother trial sites as described in Task 1.1.1. The entries will be evaluated using randomized complete block designs and the data collected and used to inform adoption and promotion strategies for the promising improved groundnut varieties. Strategic partnerships with NAFAKA farmers will be used in adoption studies.

Sub-task 1.2.3. Bambara nuts. Our baseline studies in Kongwa and Kiteto show that Bambara nut is a critical part of the food security system of farmers in the target zones. These materials are not yet available to farmers in Dodoma and Manyara sub-regions. Thus it is proposed to conduct PVS on 5 superior Bambara nut varieties namely NalBam -02, NalBam-03, NalBam -04, NalBam-06 and Myao under farmer field conditions in selected villages of Kongwa and Kiteto district. These materials are currently at National Performance and DUS tests for their release in Tanzania. The on-farm performance will generate data to support release process.

Task 1.2.4 Pilot seed production for groundnuts and pigeonpea at community level. Whereas seed distribution is a development activity, up and out-scaling is very much context (crop and agro-ecology) specific. In this task we will investigate the possibility for using local production and marketing associations to engage in Quality Declared Seed (QDS) production for their own communities and other farmers. Imperatives for communal seed banking using two legumes (groundnut and pigeonpea) will be investigated using either two existing farmer associations or 2 researcher-created groups in both districts. Farmer preferred and well-adapted released materials will be used. As backup plan on-station seed multiplication will be done at ARI-Naliendele (Groundnut and Bambara) and ARI-Selian (pigeonpea) to feed in to community based seed production. In year 4, the project team will take leadership, as capacity for management is built within NAFAKA. The Tanzania TOSCI criteria will be used to guide seed production of farmer preferred pigeonpea (2) and groundnut varieties (2). ICRISAT will backstop the process working with relevant TOSCI to train farmers and engage them in QDS production.

Task 1.3. Description of vegetables

Sub-task 1.3.1. This is a new area being brought in to enhance income diversification and improve nutrition outcomes of the project. Situation analysis to document current situation surrounding vegetable production, consumption, marketing and related statistics in the 2 districts will be undertaken. Additional work includes screening for adapted standard and traditional African vegetables in the target districts using elite and recently released varieties from AVRDC. Conduct community sensitization on nutritional importance of vegetables and demonstrations for selected vegetables along with improved best bet agronomic practices by vegetable growing farmers, schools and hospital gardens. ARI Hombolo backstopped by AVRDC will conduct this activity.

Deliverables for 2014

There are six deliverables under this work package for 2013-2014 i.e. that build on progress in 2012-2013.

1. At least two new adapted varieties each of maize (Kiteto and Kongwa) and sorghum (Kongwa) identified for semi-arid target areas.
2. At least two adapted varieties each of pigeonpea, groundnuts and Bambara nuts confirmed for semi-arid target areas for up scaling purposes.
3. Critical factors affecting adoption of improved legumes in the semi-arid areas elucidated.
4. At least one adapted variety of selected standard vegetables (tomato or sweet pepper) and one traditional African vegetable (amaranth or African egg plant) identified for target areas
5. Strategies for engaging women and other village members in community based seed production piloted and validated for up scaling.
6. Capacities of communities improved for QDS production strengthened.
7. Farmers and extension staff trained on IPM in all the selected crops.

5.2 Work package 2.

Work package number	WP 2	Start date or starting event:			October 2013 to September 2014
Work package title	Evaluation of soil fertility and water management options				
Activity Type	Action research type, R&T, participatory and promotional action				
Target (Districts-Villages	Kongwa-Chitego	Kongwa-Laikala	Kongwa-Mlali	Kongwa-Moleti	Kiteto-Njoro
WP leader	ICRAF				
Partners	ARI-Hombolo	UDOM and PRC		SUA	DAICOs
WP budget (USD)	**161, 000**				

Relevant Africa RISING Research Output: RO 2 on Integrated Systems Improvement

Key intervention areas: This work package will focus on three main issues critical for intensification of legumes and cereals in semi-arid areas of Tanzania:

1. Development of scenarios for sustainable production of cereals and pigeonpea varieties (ICEAPs 00554 and 00557) identified in the 2012/13 growing season under WP 1 that contribute to sustainable agricultural intensification and offer nutritional and marketing advantages.
2. Validate and disseminate best-bet management packages around the most promising new crop varieties and integrated soil fertility management technologies suited to widely representative agro-ecologies.
3. Resource conservation. Protect land and water resources and foster agricultural biodiversity through the introduction and management of physical and biological measures (SWC and tree-based interventions).

Description of work

Research questions

- Which fertilizer and tree-based technologies are appropriate for SI of agro-pastoral systems in semi-arid central Tanzania?
- Are soil erosion management technologies compatible with agro-pastoral farming systems of semi-arid zones of central Tanzania?
- Are *in situ* water harvesting technologies effective in semi-arid region of central Tanzania to increase crop productivity and ecological benefits to farmers?

WP 2.1: Soil fertility management

Task 2.1.1 Improving efficiency of fertilizer and manure application. In Tanzania, blanket fertilizer application rates are widely used in various agro-ecologies. Often these are rates ineffective in overcoming nutrient limitations for crop growth because farmers either apply too much or too little fertilizer since blanket rates are not site specific. Although recent work by ICRAF (Kimaro et al., 2012[7]) and NAFAKA in Kongwa and Kiteto reported low levels of nitrogen, phosphorus and carbon, and marginal to high levels of other macro and micronutrients in the soil, no work has been conducted to develop fertilizer application guidelines for Kongwa and Kiteto. These districts are also endowed with livestock that are rich sources of manure, a source of plant nutrients. As part of the integrated soil fertility management (ISFM) strategy for agro-ecological intensification in these semi-arid districts, we initiated work in the 2012-2013 season to develop fertilizer application guidelines. Preliminary results suggest that P may be the most limiting nutrient and that the optimum application rate could be 30 kg P ha^{-1} for maize under monoculture. However, farmers could apply

[7] Kimaro, A.A., Sileshi G. W., Mpanda M., Swai, E., Kayeye H., Nyoka B. I., Majule A. E., Perfect J. and Kundhlande G. 2012. Evidence-based Scaling-up of Evergreen Agriculture for increasing Crop Productivity, fodder Supply and Resilience of maize-mixed and agro-pastoral farming systems in Tanzania and Malawi. Jumpstart report to IITA.

15 kg P ha^{-1} without compromising yields. The focus this year will therefore be to validate the 2012-13 season results so as to provide conclusive guidelines on the appropriate agronomic and economic application rates and guidelines for farmers. Variable cost and net benefits analysis for each tested fertilizer and manure rates (please see experimental design and treatment section for rates being tested) will be done to identify most costs efficient application rates for various typologies of farmers found in the study sites.

Experimental design and treatments for N& P-fertilizers: Experiments will be established in Moleti, Mlali villages and Njoro villages using the randomized complete block design (RCBD) with the three replications. For the N-fertilizer trial, treatments will include control (no fertilizer), 20, 40, 60, 80 and 120 kg N/ha. Treatments for P-fertilizer rates will include control (no fertilizer), 15, 30, 45, 60 kg P/ha and for the effective source of P experiment: control (no fertilizer), TSP, Minjingu mazao and Minjingu rock phosphate applied at a rate of 30 kg P/ha in Mlali, Njoro and Moleti villages to capture a gradient of precipitation and soil conditions. Maize and pigeonpea will be the test crops.

Experimental design and treatments for manure trials: This trial will explore the synergy between the promising P-application rates with kraal manure to improve crop response to manure. Manure is a potential local source of nutrients and organic matter in highly degraded sandy soils found in the targeted sites. However, previous work in Dodoma (Kimaro et al., 2009[8]) suggests that kraal manure in Dodoma has sufficient levels of N for maize production but is deficient of P. Considering that preliminary results in the 2013 season identified P as the probable limiting nutrient for maize production, it is critical to evaluate levels of P fertilizer that may improve crop response as well as residual effects of fertilizer application. Moreover good manure application practices, such as incorporation into the soil rather than surface application as done by farmers, will be demonstrated during this trial. Treatments for this trial will include: P- application (0, 7.5, and 15 kg P ha^{-1}) with and without manure application at 10 t ha^{-1} in a factorial combination. Each participating farmer will be asked to have six plots (5 m x 6 m), one for each of six the technology combinations of manure and Minjingu mazao (rock phosphate) to be evaluated. The rate of P is based on results from the 2013 season and the manure rate selected falls within the range (10 -15 t/ha) used in previous studies in Dodoma, Tanzania and Sub-Saharan Africa (Mafongoya et al. 2006; Kimaro et al. 2009). Once added, manure will be incorporated in the soils using a hand hoe. Test crops will be promising cereal varieties (maize or sorghum based on site conditions) from WP 1.

Data collection: Data to be collected from experiments described above include biomass yield and nutrient up take at the active growth period of maize and pigeonpea, grain yields of maize and pigeonpea at physiological maturity, and variable operation costs for each treatment. Details of the experimental management, data collection, and statistical analysis can be found in the field protocol developed separately for implementation of this project.

Task 2.1.2 Integration of Minjingu mazao and tillage practices. The aim of this task is to evaluate the interactive effects of the promising P-rates and tillage practices based on the preliminary results of the 2013 season while demonstrating these interventions across the Africa RISING sites for training and promotion purposes. Treatments will involve P-fertilizer rates (0, 7.5, and 15 kg P ha^{-1}) in field with no history of fertilizer application and with previous history (Year 1 experiments), with and without tied-ridges for Kongwa district and tractor ripping for Kiteto district. Each participating farmer will be asked to have two plots (10 m x 20m), one for conventional tillage (control) and another for the tillage treatment (i.e. tied-ridging in Kongwa district or tractor ripping in Kiteto district). Tillage treatments selected were the most promising for tillage in each site based on preliminary results from the 2013 growing season. These plots will be split into 3 sub-plots (5 m x 10 m) and fertilizer rates applied randomly in each plot. This demonstration will be run concurrently with the validation experiments for tied-ridges and ripping (described in WP 2.2) so as to understand

[8] Kimaro, A.A., V.R. Timmer, S.O.A. Chamshama, Y.N. Ngaga, and Kimaro, D.A. 2009. Competition between maize and pigeonpea in semi-arid Tanzania: Effect on yields and nutrition of crops. Agricultural Ecosystems Environment 134:115–125.

the moisture and nutrient interactions may influence water and nutrient use efficiencies by crops across the Africa RISING sites. Sites will be chosen to reflect rainfall gradient with ARI-Hombolo installing field rain gauges to collect precipitation data each site.

In the 2012-2013 season, discussions with farmers and extension officers during feedback sessions revealed a number of facts and myths about fertilizer use and impacts in Africa RISING sites. These include: industrial fertilizer destroys the soil, labour involved in spot application of industrial fertilizers and transport of manure affect adopt of fertilizer-based technologies, and there is limited access and availability of manure. Thus training sessions will be held with farmers and extension officers to discuss these issues to tap farmers knowledge and experiences and also address any misconceptions so as to promote and increase awareness of tested fertilizer interventions in the Africa RISING sites.

Task 2.1.3 Harnessing pigeonpea in crop mixtures for ISFM. The aim is to test and validate suitability of pigeonpea as an integral component of ISFM for these agro-ecologies. The pigeonpea will contribute to soil organic matter as well as act as a biological ripper breaking soil hard pans using its strong tap root system. In the 2012/13 season we could not implement the trial because of poor and sporadic germination of pigeonpea in Mlali and Moleti. Thus, this experiment will be repeated in 2013/14 to assess the spatial integration of pigeonpea with cereals (sorghum and maize). Pigeonpea is a fairly new legume crop in Kongwa and Kiteto, requiring both adaptability studies (WP1) and agronomy studies particularly for intensification. Yield advantages in intercropping is determined by the net effects of positive (facilitative and complementarity) interactions and mitigating negative (competitive) interactions (Snapp et al., 2002[9]; Kimaro et al., 2009). Considering that pigeonpea is a new crop in Kongwa and Kiteto, it is critical to determine the appropriate spatial arrangement that will optimize crops yields in intercropping so as to guide farmers who will be interested to take up this crop. It is anticipated that in sub-sequent years, the promising spatial arrangement will be integrated with other legumes such as groundnuts, Bambara nuts (being evaluated in WP 1) and *G. sepium* in demonstrations to provide farmers with options for "double-up" legume interventions for up scaling purposes. A similar kind of *Gliricidia-pigeonpea* double-up legume technology has been developed at ICRAF research station in Makoka, Malawi and will be evaluated here in demonstrations.

Experimental design and treatments: This experiment will be laid out in a RCBD with three replications. The following treatments will be adopted for this study:

- Treatment 1: One row of maize alternating with one row of pigeonpea (1:1).
- Treatment 2: One row of maize alternating with double rows of pigeonpea (1:2)
- Treatment 3: Two row of maize alternating with one row of pigeonpea (2:1)
- Treatment 4: Maize monoculture
- Treatment 5: Pigeonpea monoculture under doubled-up legume

Target villages for this demonstration will be Moleti and Njoro to capture a gradient of rainfall patterns in the Africa RISING action sites. Pigeonpea variety identified in WP 1 in the 2012 season (ICEAP 0054) and Maize will be used as test crops for this trial. Data will be collected on biomass yield and nutrient up take at the active growth period of maize and pigeonpea, grain yields of maize and pigeonpea at physiological maturity, and variable operation costs for each treatment. Details of the experimental management, data collection, and statistical analysis can be found in the field protocol developed separately for implementation of this project.

Task 2.1.4 Cost benefits analyses for tested ISFWM technologies. This WP has tested several technologies including, the application rates of N and P fertilizers, spatial arrangements of cereal legumes (pigeonpea) and soil water and erosion control practices, as well as and tree-based soil

[9] Snapp, S.S, Rohrbach, D.D., Simtowe, F. and Freeman, H.A., 2002. Sustainable soil management options for Malawi: Can smallholder farmers grow more legumes? Agricultural Ecosystems and Environment 91: 159–174.

interventions to provide economic rationale for up scaling purposes. Activities in this task will focus on conducting CBA of these technologies to underpin up scaling activities in subsequent years. Among other things, the CBA will involve collection of data on the costs of; land preparation and agro-inputs, prices of grain commodities (maize and pigeonpea) and fuel-wood from pigeonpea to estimate benefits. Appropriate indirect costs and benefits of the technologies such as wood yield from pigeonpea and fodder especially nutritional value of tested tree/shrubs from crop restudies, will also be considered in the analysis.

Deliverables for WP 2.1: Soil fertility management

1. Spatial arrangements of pigeonpea and maize/sorghum intercropping in the action sites tested to provide guidelines on appropriate cropping arrangement for optimize crops yields.
2. Guidelines for fertilizer application for semi-arid zones validated for up and out scaling purposes.
3. Costs-benefits analysis of tested ISFM technologies produced to guide scaling operations in subsequent years.
4. Guidelines for integrating promising P rates, tillage practices and/or manure to enhance crop response and resource (nutrient/water) use efficiency developed and demonstrated across Africa RISING sites.
5. Two M.Sc. students (P-fertilizer trials and nutrient-by-moisture interactions) trained.

WP 2.2: Land & water management

Task 2.2.1: **Soil erosion management**. A survey conducted by the project on main causes of land degradation during 2012/2013 growing season noted that soil erosion in Kiteto and Kongwa is mainly caused by poor tillage and crop management practices, grazing on croplands and lack of knowledge on control of soil erosion among others. Due to complexities associated with agro-pastoral communities, in the 2013/2014, cropping season, we will study the practicality of installing erosion control structures as well as study their efficiency. Sensitization meetings on soil erosion management will be conducted in Mlali village, Kongwa district. Communities will also be trained through demonstrations, and field schools that rely on trained lead farmers as village level resource persons and backstopped by the project team and trained extension staff. Specifically, the study will introduce contour bunds (*fanya juu and fanya chini*) and strip cropping as strategies to minimize soil loss through surface runoff. This activity will be conducted using an iterative action research approach to test acceptability and efficacy of these control measures, working with communities to discuss, prioritize and experiment on erosion control measures.

Sub-task 2.2.1.1. Applicability of physical barriers for erosion control in agro-pastoral communities. In order to achieve control of soil erosion occurring on the landscape, during 2013/2014 cropping season, farming communities in Mlali village will be mobilized to practice both mechanical and biological soil erosion control measures. Mechanical soil erosion control measures include contour bunds (*fanya-juu and fanya-chini*), whereas biological soil erosion control measures will focus primarily on introduction of strip cropping on cropland and planting of appropriate plant species including pigeonpea on gullies as a strategy to minimize soil loss through surface runoff. Alongside the above initiatives, at the inception of 2013/2014 cropping season, demonstrations on proper ploughing techniques (i.e. ploughing across the slope) will be done as a strategy to control soil erosion occurring on cropland as a result of current of ploughing along the slope.

Sub-task 2.2.1.2. Testing of efficiency of physical barriers for erosion control. The efficiency of erosion control approaches will be tested using a runoff collection system constructed in action sites to quantify the amount of water runoff and soil loss under managed and non-managed interventions. In this regard, runoff plots for determine runoff and soil loss will be surrounded by iron sheet that will be driven into soils to a depth of 15 cm and apron and collection system will be constructed according to standard procedures. Runoff measurements data will be recorded and

calibrated as follows:

RO = Q/CA;

Where RO = Runoff, in mm; Q = Runoff volume, in l and CA = catchment in m^2.

Task 2.2.2: ***In situ*** **water harvesting technologies**. In semi-arid zones of Tanzania crops are grown in stressful environments characterised by unpredictable soil water supply, high temperature, high evaporation and limited growing season length (3-4 months) (Hatibu et al. 1995[10]). Moreover, whenever it rains, the limited soil cover and poor land management systems enhance erosion through runoff (Swai et al. 2007[11]). Climate change prediction models estimate that areas with uni-modal rainfall patterns in Tanzania will experience decreased rainfall of 5% to 15%. Thus over dependence on agriculture, low and unreliable rainfall, poverty and high livestock numbers, justify the considerations of Rainwater Harvesting (RWH) in the semi-arid areas of Tanzania (Senkondo et al. 2004[12]). Findings obtained during 2012/013 cropping season clearly indicated that the use of ripping and tie-ridging increased maize grain yields by 25% and 30 % respectively, compared to traditional tillage methods (ox-plough and disc plough). During 2012/2013 we focused on only three villages, however, during 2013/2014 cropping season, five villages will be included. The basic design of experiments is mother-baby trial described in detail for each activity. As applicable treatments will be integrated within ISFM as implemented under this work package. The main activities are described below:

Experimental design and treatment descriptions. The experiment will be carried out using mother and baby plot approach. The mother plots will consist of complete sets of treatments arranged following a randomized complete block design and replicated three times, with two mother plots per participating village. Each village shall have at least one baby plot giving a total of five per district, one for each village. Baby plots will be farmer-selected technologies following their own prioritization done during the sensitization meetings. Each baby plot will be considered as a replication and will represent preferably different farmer typologies (resource endowments and land/ farming practice used).

Treatments for investigation will vary from locations (i.e. Kiteto and Kongwa) mainly due to the sources of farm power used in land preparation. In Kiteto, we will evaluate effects of tractor driven ripper (ripping tillage) and disc ploughing on crop performance. Ripping will be integrated with herbicide use (Roundup/glyphosate) to minimize soil disturbance and keep soil cover. Two types of ripping will be done depending on the source of traction (diesel tractors or oxen). In Kiteto, tractor-driven ripping will be done three weeks later after application of herbicides, whilst in Kongwa, oxen drawn ploughing, ripping and ridging will be evaluated for impacts on soil water storage at vegetative, reproductive, grain filling and maturity stages.

Data to be collected. Data will be collected on hydrological/ physical properties of soil and crop growth as well as yield components. Data on hydrological properties of soils such as soil moisture, matrix suctions and available water capacity will be recorded. Physical properties of soil (bulk density and porosity) will be determined. Crop growth and yield variables including germination percentage, plant height measurements, dry matter yields and kernel weight will be recorded.

Factors affecting adoption of water management. This activity will be done to together with WP5

[10] Hatibu, N; Mahoo, H.F., Kayombo, B; Mbiha, E; Senkondo, E.M; Mwaseba, D and Ussiri, D.A.1995. Soil and Water Management in semi-arid Tanzania Research Project. Research News, DRPS, SUA. 5 : 13-15.

[11] Swai, E.Y and Rwehumbiza, F., and Chambo H. 2007. Effect of residual tie ridging on soil hydrological properties and crop performance in Central semi-arid Areas of Tanzania. Pp 325 – 336. In: 2nd Scientific Symposium on Opportunity for increasing Water Use Efficiency in agriculture in semi-Arid and Arid areas of SADC Region. 20 -22 February 2007. The Grand Palm Hotel, Gaborone, Botswana.

[12] Senkondo, E. M. M., Msangi, A. S. K. Xavery, P., Lazaro, E. A. and Hatibu, N. 2004. Profitability of Rainwater Harvesting for Agricultural Production in Selected Semi-Arid Areas of Tanzania**.** Journal of Applied Irrigation Science 39: 65 – 81.

on R4D platform. The aim is to engage communities in innovation processes that will help improve research design and implementation. Critical for this process is the knowledge transfer mechanisms. We will investigate effectiveness of lead farmer based farmer-to-farmer knowledge transfer. The lead farmers will be trained on tillage and erosion management. They will then be requested to use these acquired knowledge to train fellow farmers on their personal plots. In Kiteto the focus shall be on *insitu* water harvesting technologies developed by tractor driven implements, whilst in Kongwa the focus shall be on ox drawn implements. In Kongwa, farmers will be trained on fabrication of appropriate yokes required for draft animals to implement field operations notably ridging and ripping for draft animals. All training shall be done prior to the onset of rainy season for timely and efficient field operations. Two on-farm surveys at the mid-season and end of the season will be conducted in both villages to gauge success of the approach compared to the field day which will be run as a control.

Deliverables for WP 2.2: Land and water management

1. Best bet soil water conservation technologies identified and promoted in drought areas of Kiteto and Kongwa district.
2. Soil water erosion control measures introduced and popularized in erosion prone areas of Mlali village.

WP 2.3: Trees for enhancing fodder and crop production

Task 2.3.1. **Shelterbelt and/or boundary planting**. Landscape-based agroforestry technologies for addressing the problems of soil erosion, fodder, fuel wood and timber supply in action sites will done including shelterbelt and boundary planting. Four to six strips of double rows of *G. sepium* will be planted in the field at 50 m apart and at least 100 m long to reduce wind and water erosion. Plant spacing within each strip will be 2 m within tree rows and 3 m between the tree rows. *G. sepium* has multiple stems, is less palatable and thus may reduce heavy browsing pressure and effectively reduce wind erosion in sub-sequent years when established in the fields. ICRAF work in Morogoro and Tabora regions in Tanzania (Kimaro et al., 2008) and Malawi (Mkumba et al. 2007) indicate that this species is compatible with associated crops even after 5-12 years of continuous growing in the field. Thus minimum belowground effect on companion crops is expected close to the shelterbelt strips. Pruning regimes will be developed in subsequent years to allow production of fodder and fuel wood and maintenance of the shelterbelts during the off-season. Soil samples will be collected for initial site characterization at the establishment and crops yield data will be collected annually from the micro-plots of 2 m x 2 m at 2 m, 6 m, 10 m, 20 m, 30 m, 40 m from each shelterbelt strip to determine crops yield responses with distance from the strip. Total farm productivity (crop, fodder and wood yields) will also be assessed in 2015 and/or 2016. Soil samples will be collected from these plots at the end of the 2016 growing seasons to assess soil nutrient and organic carbon dynamics over the 3 growing seasons. Farmers will also be encouraged to plant other tree species for fruits and wood products (timber and fuel wood) supply such as *Melia azedarach*, *Grevillea robusta*, *Acacia crassicarpa* and *Tamarindus indica*, within the double-row of a shelterbelt, in farm boundaries or at homestead to increase agro-diversity and provide ecosystem services (fruits, fuel-wood, carbon sequestration etc.) to sustain a productive farming system.

Task 2.3.2. **Integrated crop/livestock productivity enhancement**. This activity will be implemented starting in 2013-2014 and rolling over to the succeeding years. The aim is to study the complementary effects of trees as sources of forage and multipurpose uses (e.g. fuel-wood supply, live fencing, erosion control, soil fertility and supply of leaf meals for poultry and feed supplements for livestock etc.) in these agro-pastoral communities. In 2013-2014, the tree/shrubs will be raised from central and satellite nurseries for establishment of pure stands, woodlots and fodder banks to enhance crop, poultry and livestock productivity. The nurseries and tree stands and fodder banks will also serve as training and demonstrations areas to farmers and livestock keepers on raising and management of fodder production. Forage and fertilizer tree/shrub species to be planted will include herbaceous material such as *Cenchrus ciliaris*, *Cyonodon plectoschytus, Chloris gayana, Medicago sativa*, *Macroptilium atropeureum*, and *Clitoria ternatea.* Shrub will include species such

as *Gliricidia sepium*, *Leucaena diversifolia* and *Calliandra calothyrsus.* Tree species will include *Mellia azedrach*. Training on rising of the tree/shrub germplasm and their management on farm will be conducted. Furthermore, this task will be responsible for tree germplasm supply to provide planting materials for research in other work packages for current and subsequent years through local capacity developed.

Growth and biomass data will be collected to guide advisory information to be provided to farmers during training and demonstration sessions. Data to be collected at nursery and woodlot/fodder bank will include: foliage biomass for grasses/herbaceous species, and tree height, root collar diameter, diameter at breast height (dbh) and survival. Selective management for establishment of seed orchard will be done for some species including *G. sepium* and *Calliandra callothyrsus,* and later, seed production will be documented. This information will provide insights on the productivity and the potential for meeting livestock/poultry feeds demand in the action sites. A survey of the tree and shrub seeds and seedlings supply systems will be conducted to understand the bottlenecks and potentials in attaining sustainability of the germplasm availability in the project action sites.

Deliverables for WP 2.3

1. Integration options for trees on farm for fodder and wood supply, wind erosion control, and soil fertility improvement developed.
2. Screening and propagation of candidate grass and tree forage species for integrations on farm and supply of feed resources supplements for livestock and poultry production enhancement.
3. Economic advantages of tree-based interventions determined to guide scaling up work
4. Farmers trained on best practices for propagation of fodder tree and grass species.

5.3 Work package 3.

Work package number	**WP3**	**Start date or starting event:**			October, 2013 to September 2014
Work package title	Integrated livestock and poultry management for productivity enhancement				
Activity Type	Action research type, participatory and promotional action				
Target areas (Districts-Villages	Chitego	Mlali	Moleti	Njoro	Laikala
WP leader	ICRAF				
Partners	UDOM	Pasture Research Centre Kongwa			DAICOs
WP budget (USD)	**60,000**				

Relevant Africa RISING Research Output RO2 on integrated systems improvement

Key intervention areas:

- **Conservation of rangeland**. Promote natural resources management (farmland and grazing land) at a landscape level through improved rangeland productivity, grazing land management and quality of supplemental feed resources.
- **Gender empowerment**. Harness special opportunities available to women farmers as technical innovators, resource managers and homemakers.

Description of work

Research question/hypothesis

- Water availability influences rangeland quantity and quality (plant types and survival) during the rainy season and therefore feed supply during the year.
- The agro-pastoral socio- ecological contexts of Kongwa and Kiteto are amenable to practices

that can improve rangeland management, crop productivity and diversification, strengthen livelihoods of communities living in drylands.

Task 3.1. Availability of grazing and feed resources

Sub-task 3.1.1. Evaluation of quantity and quality of feed resources during wet season: The proposed work builds on dry season characterization of feed resources that was conducted from August – October 2013. Extending assessment of quantity and quality of feed resources in the wet season is necessary to generate the yearly feed availability calendar. The calendar will be used to develop sound supplementary feeding strategies for livestock in the target districts. Candidate feed resources for subsequent animal feed supplement trials will be identified and their seasonal availability assessed. Rangeland biomass productivity will be assessed quarterly through clipping of herbage material and determination of their nutritive values. FEAST will be used a complementary analytical process.

Task 3.2. Improving management and productivity of grazing areas. This task focuses on testing options for enhancing rangeland management to improve quality and quantity of pasture. Our year 1 studies, revealed contrasting grazing options being used in Kongwa and Kiteto during the wet and dry seasons. During the wet season, livestock in Kongwa are grazed on fallowed land, while in Kiteto the majority of livestock are grazed on traditional forage reserves known as '*Alalili*'. This difference reflects variations in farming systems and land use systems. Stocking levels, local institutions and by-laws that regulate utilization of grazing resources and management options differ between these two grazing systems. Moreover, livestock production among agro-pastoralists in Laikala village in Kongwa is characterized by overstocking, declining rangeland biomass productivity, and low quality of herbage forages. The latter scenario cuts across Kongwa district. Dry season feed shortages in both districts is severe. However, little has been done to understand these systems and its impacts on crop production and farmer-livestock conflicts are common in the action sites. Thus, we propose to conduct in depth studies to improve production and quality of pastures in rangelands and on traditional institutions and regulations for Kongwa and Kiteto using *Alalili* and the fallow grazing systems as case studies. Although the *Alalili* grazing system is found in areas outside the Africa RISING study villages, it offers a learning ground to understand the efficacy of fallow grazing systems in one of the Africa RISING sites. We will also review outcomes of the IFPRI and WUR studies to enrich design and implementation of research activities.

Sub-Task 3.2.1. Assessing the role of local institutions in grazing land management

This task will focus on assessing the role of local knowledge as well as traditional institutions and regulations in the management of grazing land in Kongwa and Kiteto districts. Participatory approaches such as participant observations, key informant interviews, focused group discussion; matrix ranking and structured questionnaires will be used to collect information. Data will be collected on but not limited to, existence of grazing reserves/fallow land, regulations governing forage management and grazing reserves, fodder species (tree/shrub and grass) in the reserves, contribution of the grazing reserves to natural resource management, management interventions, (if any), done in the reserves. It is anticipated that this task will generate information on how livestock dependent communities in both districts use their rangelands and provide study options for improving rangeland management under traditional management *Alalili- systems* and communal fallow systems.

Sub-Task 3.2.2: Improving production and quality of pastures in the grazing land. Exceeding rangeland carrying capacity often accelerates land degradation. Accordingly, as part of improving rangeland management, research activities under this task will focus on establishing the optimal stocking rates for grazing lands and enrichment planting of tree/shrub and grass fodder grasses in selected fodder reserves (e.g., *Alalili* or the fallowed land) to improve pasture quality. Enrichment planting involving selective planting of forages (trees/shrubs or grass species) in open spaces of natural woodlands will be done to increase tree density or vegetation cover and improve pasture production. A variety of locally adapted fodder species identified during the preliminary survey will

be planted during both 2013/14 1and 2014/15 planting seasons and assessed for their fodder production potential. These include: herbage materials: (*Cenchrus ciliaris*, *Cyonodon plectoschytus, Chloris gayana* and *Bothchloa insclupta*) herbaceous legume species (*Macroptilium atropeureum)*, *Clitoria ternatea* (Clitoria) and *Centroscema puberscens*); and forage tree legume species (*Gliricia sepium* (Gliricidia), *Leucaena pallida* (Pallida) and *Mellia azedrach*. *Cenchrus ciliaris*, *Cyonodon plectoschytus* and *Bothchloa insclupta* are perennial and withstand heavy grazing pressures. Similarly, herbaceous legume species *M. atropeureum*), *C. ternatea* (Clitoria) and *C. puberscens* are drought resistant and could withstand moderate grazing pressure. In addition, forage tree legume species (*Gliricidia sepium* (Gliricidia), *Leucaena pallida* (Pallida) and *Mellia azedrach* are resilient in these semi-arid areas. The fodder trees produce edible foliage biomass throughout the year and are highly compatible in the existing farming systems. Composite samples of grass and tree forage will be collected from the grazing reserves for dry matter determination and laboratory analysis of nutritive value indices such as total protein, crude protein, natural detergent fibre, acid detergent fibre and acid detergent lignin. Grass samples will be collected using a iron quadrat (0.5m x 0.5m) while tree/shrub foliar samples of 10-12 trees per species will be harvested manually from 70 m x 70 m temporary established plots in the fodder reserve/bank as well as grazing lands. Analysis of forage production and quality will be repeated annually at the end of the rainy season (May/June) and the dry season (October/November) to assess changes in pasture quality as result of enrichment planting. The fodder reserve/enclosures will be kept out of animal grazing during the study period following procedure used by farmers.

Task 3.3: Improving poultry management for enhanced productivity in the action sites. This task has two main activities: (i) Explore technology imperatives for improving productivity of free-range chicken; (ii) Build capacity of farmers on appropriate poultry management based on best practices in order to improve productivity. This training will form the basis for selecting farmers for trials on improved feeding and nutrition through supplementation of local and improved strains of local chicken. In the technology validation component, the aim is to study genetic potential of local chickens as part of genetic intensification efforts. This knowledge will inform scaling-up and-out efforts. Locally available feed resources (sources of energy and crude protein), mainly, maize bran/ homing meal; supplemented with fishmeal, vegetable wastes and *Medicago sativa* leaves will be used. Chickens from selected three strains of chicken will be studied under free range and confined individual pens for each strain and receive treatment diets indicated below throughout the nine (9) experimental periods. Local breeds of chicken of desirable meat attributes/ qualities (high growth rates, high carcass weight and other carcass characteristics) will be selected from local chicken population from Kongwa, Mpwapwa, Chamwino, Manyoni and Singida districts. These semi-arid districts can engage in improved poultry production, however, that potential has not been optimized. Consideration will thus be made on selected local strains such as '*Kishingo*', '*Sasamala*' and '*Kuchi*'. Cocks of these promising breeds of chicken will also be obtained from Tanzania Livestock Research Institute (TALIRI) at TALIRI Mpwapwa of Mpwapwa district, which is mandated to carrying out research related to improving livestock in the semi-arid areas. Promising local chicken breeds will be ranked using participatory approaches involving farmers and distributed among farmers for further testing on-farm. For each farmer, breeds of similar size and age will be chosen and initial weight recorded prior to the commencement of the experiment so as to account for differences in initial body weight during the measurements. The local breeds of chicken will be assessed for growth performance in terms of body weight and carcass weight as well as other carcass quality attributes such as dressing out percentage and meat quality attributes (colour, percentage of fats).

Experimental design: Effect of protein and energy supplementation on growth performance and meat productivity of selected promising local breeds of chicken:

Experimental animals. A minimum of 60 hens for each treatment for each of the three (3) most promising local breeds of meat chicken ecotypes and 60 hens of one local breeds of chicken regarded of low productivity, which will be used as a negative control, will be evaluated to make a

total of 260 chickens being 240 hens plus 20 cocks per replication. The experiment will be replicated four times to give a total of 1040 chickens (960 hens plus 80 cocks in a ratio of 1:12 cock to hens ratio for appropriate chicken breeding purposes.

Animal management: Appropriate housing for the chicken will be used following clarifications with communities. The chickens will be housed in-group pens and will be fed throughout the nine (9) month experimental duration. The experimental chickens will be divided into four groups based on strains attributes/ characteristics. Each group of 60 chickens will be provided with 5 cocks to make a recommended ration of 1:12 cock to hens, which is a recommended ratio for appropriate chicken mating.

Experimental diets:
A completely randomised design experiment will be conducted whereby the four treatment diets will be allocated to each of the 60 chicken – four groups replicated four times. The chickens will be fed with four (4) diets:

- Treatment 1: 0% inclusion of *Medicago sativa* (Lucerne) leaf meal (MLM);
- Treatment 2: 10 % + MLM
- Treatment 3: 20 % + MLM
- Treatment 4: 30 % + MLM

MLM = *Medicago sativa,* leaf meal, a protein source (Fish meals), basal energy- Maize bran and crashed maize.

Recommended levels of crashed maize, maize bran/homing meal that constitutes an energy source will be offered uniformly among all the experimental groups. The maize grains will be crushed through 5 mm screen. Homing meal will be obtained locally from cereal millers. Fishmeal will be applied at 5% of the diet so as to diversify protein source. Fishmeal will be compounded from locally sold sardine fish or 'small fish' locally known as "*dagaa*". Sardine fish are easily available from local markets. The sardines will be milled to pass through a 5 mm mesh size. Farmer will be trained on feed/ ration formulation. Farmers will also be encouraged to use supplementary feeding on fishmeal. Vitamins, minerals (especially calcium) and water will be provided as per standard recommendations. Growth parameters such as growth rate, carcass weight and carcass attributes (dressing out percentage, meat colour and fat) will be assessed.

Deliverables for 2014

1. Quantity and quality of the grazing land pasture resources determined.
2. Local institutions and their roles in grazing land management documented to guide future interventions.
3. Poultry production enhanced through introduction of improved cocks and hatchery management.
4. A female graduate student trained on pasture quantity and quality evaluation in grazing lands.

5.4 Work package 4.

Work package number	**WP 4**	**Start date or starting event:**		October, 2013 to September 2014		
Work package title	Sustainable intensification approaches to improve food and nutrition security					
Activity Type	R&D, R&T, participatory and promotional action					
Target Districts-Villages	Chitego	Laikala	Mlali	Moleti	Njoro	
WP leader	ICRISAT					
Partners	ARI-Hombolo	SUA	CIMMYT	Tuboreshe Chakula	AVRDC	NAFAKA
WP budget	**60,000**					

Relevant Africa RISING Research Output RO2on Integrated systems improvement

Key intervention areas:

- **Household nutrition and food safety**. Improve household nutrition, food safety and security among the most vulnerable households and their members, especially women and children.
- **Gender empowerment**. Realize the special opportunities available to women farmers as technological innovators, resource managers and homemakers.

Description of work

Over 50% of rural communities in Dodoma and central semi-arid zones of Tanzania are food insecure, with limited access to sufficient, safe and nutritious food needed to maintain healthy and active lives[13]. In such communities, consumption of dry land cereals, the main source of basal energy and protein, is less than 200 kg per year[14][15] due to large yield gaps of about 50%[16]. Increasing agricultural productivity in a sustainable way is one of the surest ways of addressing food and nutrition insecurity as espoused in the L'Aquila declaration of food security[17]. The objective of this work package is to contribute towards strengthening livelihoods strategies of agro-pastoral communities of Kongwa and Kiteto as part of sociological- and ecological intensification efforts by Africa RISING. This work package will contribute to the completion of three key elements of sustainable intensification[18] (genetic, ecological and sociological), being implemented by this project. We will experiment on various technologies needed to improve food availability, food access, and utilization of food, core elements of food security[19]. Specific focus on heritable resistance to pests, and pathogens, as well as processing will be investigated in the context of social and ecological systems of the communities.

Research questions

1. Genetic variation for resistance to insect pests and grain mould exists among elite sorghum and pearl millet and can be effectively deployed to minimize crop losses and mycotoxin contamination.
2. Post-harvest losses in cereals can be effectively managed through deployment of improved storage and handling technologies
3. Deployment of pre-harvest handling procedures and simple mechanical sorting post harvest can minimize infection by aflatoxigenic fungi, thereby reducing aflatoxin contamination

[13] World Bank 2009. Accelerated food security program of the United Republic of Tanzania under the global food crisis response program. Report No: 48549-TZ.

[14] Ouma, J.O., Bett, C. and Githaigah, T. 2010. Market Access, Approaches and Opportunities for QPM based products. Paper presented during the Joint 3rd African Association of Agricultural Economists and 48th Agricultural Economists Association of South Africa Conference, Cape Town, South Africa, September 19-23, 2010.

[15] Jan de Graaff, Aad Kessler and Jan Willem Nibbering, 2011. Agriculture and food security in selected countries in Sub-Saharan Africa: diversity in trends and opportunities. Food Security 2011 3:195–213.

[16] Kongwa Kiteto team progress report Quarter 3 2013.

[17] L'Aquila Joint Statement on Global, Food Security 2009. Food Security Initiative The Joint Statement on Global Food Security endorsed by the G8, SEverel EU countries, Australia, Brazil, Denmark, India, Indonesia, African Union, Mexico, The Netherlands, China, Republic of Korea, Commission of the African Union, FAO, IEA, IFAD, ILO, IMF, OECD, The Secretary General's UN High Level Task Force on the Global Food Security Crisis, WFP, The World Bank, WTO, AGRA, Group on International Agricultural Research (CGIAR), Global Donor Platform for Rural Development, Global Forum on Agricultural Research (GFAR).

[18] The Montpellier Panel, 2013. Sustainable Intensification: A New Paradigm for African Agriculture. London: Agriculture for Impact.

[19] Makalle, A.M. 2012. Post Harvest Storage as a Rural Household Food Security Strategy in Tanzania. Journal of Science and Technology 2:814-821.

levels to 4 ≤20 ppb the acceptable levels in stored legumes and cereals.

4. Women play essential roles in reproductive (home management) and community activities that can be harnessed to improve nutrition outcomes of families.

Task 4.1. Improving food availability by reducing post harvest losses. The results of the farmer survey conducted during 2012-2013 season show that farmers in the study area utilize poor grain handling approaches (harvesting, drying, grading and storage) that increase post harvest losses. These losses increase vulnerability of communities leading to limited food availability especially in February-April season. In the 2013-2014 season, we will address these challenges by testing single and combined technologies aimed at reducing losses to insect pest and opportunistic fungal infections.

We will initially work with sorghum, pearl millet and groundnuts, the key food security crops of these regions[20]. All new sorghum and common materials among farmers stocks will be included in pest resistance screening. Treatments will include evaluation of resistance to insect pest (bruchids the main pest)- candidate resistant sorghum genotypes will be fed to bruchids and evaluated for resistance. Technologies that reduce damage such as PICS bags and storage insecticide powers will also be evaluated for single or combined efficacy, when applied to tolerant and susceptible material in combination with storage pesticides. Other studies have shown that in Kongwa, grain mould development is limited due to low humidity (Makalle, 2012). Our own studies however show that grain (legumes and cereals) obtained from households all have over 4 ppb the maximum threshold for aflatoxin. This stage of the work will focus on experimental work under lab conditions.

During harvesting period successful experiments will be evaluated in target communities that also grow pearl millet affected by bruchids. Work will be done at NAFAKA and Africa RISING sites where the communities have already been mobilized. Scaling-up and out action will be done in new areas after validation at NAFAKA sites. Further in 2014-2015 promising components will be scaled up for scaling up in communities and the benefits will be documented. Scaling up and out will experimented using the farmer to farmer extension system, a system that allows capture of local knowledge as well as disseminate rapidly to communities. The R4D staff will backstop the up-scaling approaches.

Task 4.2. Improving food safety by mitigating aflatoxin contamination. In our 2012-2013, studies, we found that cereals especially sorghum and maize, as well as legumes (groundnuts and Bambara nuts) all had high levels of aflatoxin. Yet these crops are the food security crops of these dry lands. In the 2013-2014 season, we will initiate efforts to reduce exposure to contaminated staples. We will experiment on a number of activities jointly implemented with the Babati team.

1. Use appropriate communication media to disseminate messages on aflatoxin. This will be done in combination with on-going efforts by IITA, ICRISAT and Government of Tanzania.
2. Conduct community action research to learn and promote mitigation efforts in communities. Key activities will include training women-farmers and traders on simple post-harvest management practices to reduce contamination, including proper drying, grading and storage. (Using different storage bags, platform and grading based on various aspects). Initially, work may not involve all promising material coming out of WP1 but will do so as more grain becomes available. This activity will be linked with Africa RISING Babati team to harmonize technologies across the target sites.
3. The nutritional value and aflatoxin contamination possibilities of grain amaranth will be analyzed and evaluated with AVRDC. Awareness campaigns on aflatoxin will be conducted using appropriate media. The communication product developed by NARI and Babati Team

[20] Konga/Kiteto baseline survey 2013 shows that these crops in combination with maize influence all year availability of cereals and incomes that can then be used to purchase more food.

will be used including radio programme, leaflets, video animation and cartoon posters and feedback will be collected on the knowledge gained. Evaluation of techniques to reduce grain contamination at pre-and-post harvest levels will be conducted. The materials from WP 1 will be evaluated for aflatoxin resistance/tolerance.

4. Study dynamics of *Aspergillus flavus* in the soils and the associated aflatoxin levels in groundnuts to guide development of management options. This will be a follow up of our year 1 studies
5. Additionally, we will develop a diagnostic platform at ARI Hombolo for the target area working, with Selian Research Institute, and build capacity of ARI Hombolo and Selian Research Institute to diagnose aflatoxin in grain. We will engage the Tanzania Food and Drug Authority and other relevant other associate partners who will be contacted in course of the project. In 2014-2015, the adoption rate of technology will be evaluated and monitored and the aflatoxin mitigation rate will be recorded.

Task 4.3. Improving nutrition. This task aims at improving nutrition outcomes of households using a set of activities that will improve dietary availability, consumption and food safety.

1. **Increasing consumption of legumes as protein sources**. The activity aims at improving consumption of these legumes complementary sources of protein. In Year 1 our household baseline studies conducted in Kongwa and Kiteto indicated that legumes are the major source of dietary proteins, with Bambara nuts playing a critical role in ensuring year round availability. These legumes however show high levels of contamination (70% of groundnut samples had up to 4000 ppb; whilst 43% of Bambara nuts had 1-411ppb -data taken in 2012-2013) and may thus contribute to poor health of communities. Aflatoxins among others also compound bioavailability nutrients. In this activity, three legumes will be used i.e. groundnuts pigeon peas and Bambara nuts. We will study nutritional benefits of combined use of cereals and legumes being investigated to underpin up-and out-scaling.

   Children (below five years) will be fed complementary food based on groundnuts, Bambara nuts and pigeonpea developed by the project. We will work in the Tuboreshe Chakula targeted areas to complement their activities and access families they are working with as well as their expertise. Prior to feeding the children, aflatoxin levels in grain will be analyzed. The project team with the assistance of the Ward/Village medical personnel will establish baselines on height and weight of the study cohort children. Mothers will be taught how to prepare complementary legume and cereal based foods and requested to feed the children with the prepared food in their homes. Three different cohorts will be used for each of the legume being investigated. Measurements of height and weight will be recorded in prepared cards and continue taken on a monthly basis for a year by ward/village medical personnel. Collected data will be used to calculate Weight for Age Z-Score (WAZ), Height for Age Z-Score (HAZ) and Weight for Height (WHZ) which are determinants of the nutritional status of children. This activity will be done in partnership with Tuboreshe Chakula. The aim is to ramp-up demand by increasing consumption of aflatoxin free legumes.
2. **Processing of pigeonpea/groundnuts/Bambara and utilization**. In these communities, the major sources of protein are Bambara nuts and to a limited extent, groundnuts. However these communities grow pigeonpea with limited consumption. The aim of this activity is to expand the dietary scope by encouraging household consumption of pigeonpea. Acceptable processing technologies including dehulling and split dhal making will be tested and or demonstrated in partnership with Tuboreshe Chakula, with new women groups in target areas. The varieties from WP 1 will be evaluated for the easy processing and its utilization. Demonstrations for utilization such as Bonko, Mseto, Ngande Soup and Dhal, as well as recipes for cooking will be made available to households. The new combination recipes of groundnut and Bambara nuts will be evaluated. This action will be implemented in partnership with relevant ARI, NARI and other associate partners, who will be contacted in

course of the project. We also explore the use of grain amaranth to improve nutrition in legume-based diets. The activities aim to reach wider audiences of women communities including home gardens which have been shown to increase opportunity to deliver nutrition outcomes.
Deliverables for 2014 1. A gender based analysis of agricultural enterprise in at least two villages of each district to inform gender based implementation nutrition and food security conducted. 2. At least 10 key farmer leaders per village trained on post-harvest management of grains to minimize aflatoxin contamination. 3. Preliminary results for approaches to mitigate food losses, and aflatoxin contamination in generated. 4. Strengthen the capacity of ARI Hombolo and Selian Research Institute to detect aflatoxin in various crops. 5. Train NAFAKA, Tuboreshe Chakula and Hombolo staffs on aflatoxin management and detection. 6. Aflatoxin hot spots area mapped for targeted intervention. 7. Farm families made aware and encouraged to use micronutrient supplements supplied by Tuboreshe Chakula. 8. A network of partners to support aflatoxin mitigation efforts in the two regions developed and or strengthened. 9. Effect of weather changes on *Aspergillus* population and aflatoxin contamination in various crop documented at least for 2 seasons (2013-2014 and 2014-2015).

5.5 Work Package 5

Work package number	**WP 5**	**Event period:**			December 2013 to September 2014	
Work package title	Innovation Platforms developed to inform R4D targets and processes					
Activity Type	Action research, capacity building for farmers and extension staff					
Target areas (Districts- Villages)	Kongwa-Chitego	Kongwa-Laikala	Kongwa-Mlali	Kongwa-Moleti	Kiteto-Njoro	
WP leader	ICRISAT					
Partners	ARI-Hombolo	UD	CIMMYT	ICRAF	ARI-Naliendele	PRI-Kongwa
WP budget	**94,020**					

Relevant Africa Rising Objective 2: Integrated systems improvement
Key intervention areas. Many farming communities of the semi-arid zones districts of Kongwa and Kiteto in Tanzania practice agro-pastoralism, growing maize, sorghum and pearl millet as cash and staple crops. Additionally, dry land adapted legumes such as groundnut, pigeonpea and Bambara nuts are commonly produced[21]. Our household and pastoral system studies of 2013, show that these cereals and legumes initially sustain food, nutrition and income security and subsequently, their crop residues serve as livestock feed during lean periods. The studies also show divergent management systems of pastures and rangelands in both districts. In Kongwa, communal fallow systems are used, whilst in Kiteto, well-managed traditional systems known as *Alalili* are used. Under the *Alalili* and fallow systems, crop residues and forage trees are essential components of feed supply. Moreover, in the broader Manyara region where both districts are found, there is increasing take-over of wet season grazing lands for arable farming[22], a potential source of conflict but opportunity for

[21] Okori et al., 2013. Intensification of maize-legume based systems in the semi-arid areas of Tanzania (Kongwa and Kiteto districts) to increase farm productivity and improve farming natural resource base. Final Report for 2013 submitted to Africa Rising Secretariat.

[22] Flintan, F, 2012. Participatory rangeland resource mapping as a valuable tool for village land use planning in Tanzania.

integration as well. Through this work package, communities and stakeholders will be engaged in research and innovation using the Innovation Platform approach to improve functionality of selected value chains.

The Africa Rising Research Framework proposes that Innovation Platforms be used initially to identify critical value chains for targeting of research intervention, but since the team already has specific commodities identified through prioritisation and own research efforts, the focus shall be to improve functionality of these identified value chains. The project will thus start from step 2 of Africa RISING Research Framework Innovation Platform establishment strategy i.e. platform establishment. The Innovation Platform will be managed using the guiding principles set out in the Africa RISING Research Framework and IAR4D[23] principles to deepen understanding on delivery of Africa RISING output 2. This work package will involve two mutually reinforcing components i.e. R4D to clarify the effectiveness of technology integration and the Innovation Platform to elucidate contexts (R4D entry points, draw lessons and partnership opportunities) of innovation and adoption processes. The research will be implemented under WP's 1-4, whilst the Innovation Platform will inform the scope of the R4D being implemented. Further details are provided below.

Description of work

Research hypothesis

1. Farmers and allied stakeholders in the semi-arid zones of central Tanzania have an understanding of agro-ecological and value chain needs of their region that could be targeted through R4D for productivity and value chain functionality enhancement.
2. Nutrition outcomes require targeted interventions that enhance social (participatory processes and gender concerns) and human capital assets of communities.

Task 5.1. Harnessing innovation platforms to support innovation.

Innovations have been defined variously but in general, encompass new methods, processes, or products that perform new tasks and in the case of agriculture support increased productivity[24]. Within the Africa RISING context, agricultural innovations include combinations of technological innovations, social and or institutional innovations that increase productivity along value chains. The generation of these innovations ultimately requires multi-stakeholder participatory processes that involve communities[25]. This project has four R4D work packages that identify and integrate innovations for promotion at appropriate scale in communities. However, the success of future adoption and scaling up-and-out efforts depends on sound understanding of community socio-economic contexts of agricultural innovation during and after the research process. In general, understanding of biophysical and socio-ecological contexts is essential for undertaking sustainable intensification at community level (Montpellier Panel, 2013)[26]. This work package aims at deepening understanding of how innovations can be developed within agro-pastoral communities of central

International Land Coalition, IFAD, CARE Tanzania, KINNAPA Development Programme, Ministry of Livestock and Fisheries Development, local government and CSO partners.

[23] Adekunle, A.A. and Fatunbi, A.O. 2012. Approaches for Setting-up Multi-Stakeholder Platforms for Agricultural Research and Development. World Applied Sciences Journal 16: 981-988

[24] Sunding, D and Zilberman, 2000. The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector. In the Handbook of Agricultural Economics. Department of Agricultural and Resource Economics, University of California at Berkeley.

[25] Africa Rising Programme Document. IITA, Ibadan.

[26] Montpellier Panel, 2013. Sustainable Intensification: A new paradigm for African Agriculture, London.

Tanzania to solve agro-ecological challenges and improve functionality of targeted value chains (Figure 2). This process will in part underpin scaling up-and-out actions[27].

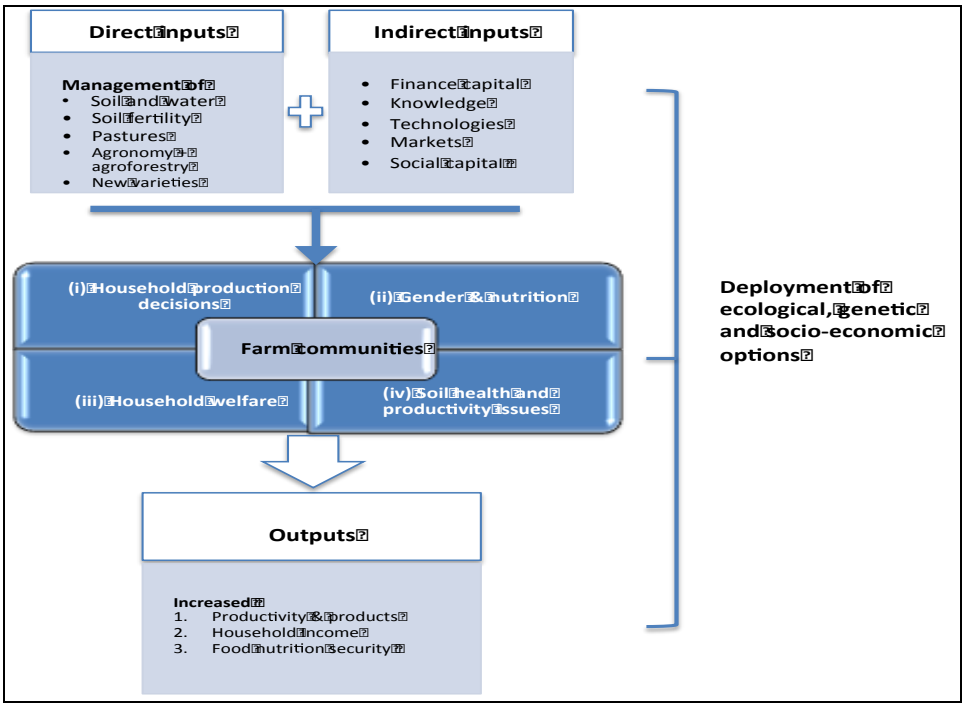


Figure 2. Integrated deployment of ecological, genetic and socio-economic options for intensification within agro-pastoral communities of central Tanzania will support sustainable productivity increase value chain improvements and livelihoods. The figure is modified from Montpellier Panel, 2013.

Two Innovation Platforms will be established at site level (Kongwa and Kiteto) rather than district level to get sufficient stakeholder threshold. The establishment of the Innovation Platforms is due to the fact that in general agricultural productivity enhancing innovations do not necessarily lead to improved nutrition outcomes at household level[28]. At project level however, information generated from both platforms will be used to inform the integration of R4D interventions at community level, drawing from the commodity and the nutrition Innovation Platforms. A brief write-up of each Innovation Platform is provided below. Detailed implementation guides will be developed to guide day to day operations.

Subtask 5.1.1. Strengthening functionality of selected value chains via innovation platforms. This Innovation Platform will seek to clarify issues needed to improve functionality of selected value chains, the key ones being maize, groundnut and pigeon peas, and how they are linked to agro-pastoral production systems of Kongwa and Kiteto. Agro-forestry based interventions and how they could be used to improve soil fertility, pasture management, food and incomes will be integral part of this Innovation Platform. Establishment of one Innovation Platform addressing various value chains is underpinned by the fact that better resource use efficiency will be attained at that level because most of the value chain actors are usually the same and so are the policy and agricultural support services. As appropriate however, actors within a specific value chain may discuss unique issues to their value and market chain to inform the scope of research being undertaken. The Platform will inform on-farm research by clarifying priorities and opportunities for implementation.

[27] Per Hillbur, 2013. Research on institutional innovation and scaling issues in Africa RISING. Consultancy report submitted to Africa RISING Secretariat

[28] Berti, P.R. Julia Krasevec, J. and FitzGerald, S. 2004. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. Public Health Nutrition: 7: 599–609.

This Innovation Platform will also be used to understudy how best to improve rangelands and poultry productivity (ecological and genetic options). The pasture work aims at reducing seasonality of pasture available to improve productivity of the two systems common in these dry lands i.e. the traditional fallow systems and the managed pastures or *Alalili*. It shall inform the work being done at community level in WP3. And where possible key stakeholders will be invited to engage farmers at experimental sites of WPs 3 where learning and research activities will be taking place. Lessons that can be used across both systems will be harnessed. This activity will also clarify on R4D issues for poultry production and how poultry and livestock could be integrated with arable farming in these semi-arid tropics to improve overall productivity. This platform will be managed by ICRAF/ University of Dodoma and Pasture Research Institute-Kongwa and ICRISAT- and allied stakeholders. The following steps will be undertaken to establish the platforms:

1. **IP establishment**. This shall be developed via a community meeting involving the farmers, community leaders, extension agents and relevant development agency actors and other partners especially market value chain actors. The first meeting will be used to:
    a. Define the scope of the partnership for selected value chains, develop consensus on critical research problems in selected communities and identify the first significant issues for engagement through R4D.
    b. Identify leaders (community champions and their roles) who work together with selected stakeholders as facilitators of the Innovation Platforms.
    c. Establish Innovation Platforms following the principles adopted and modified from Africa RISING Research Framework and experiences from elsewhere such as:
        - Use of the platform to diagnose problems, explore opportunities and investigate solutions through a facilitated process.
        - Support R4D that addresses priority constraints and opportunities agreed upon by actors.
        - Non-linear collective and collaborative interactions among key stakeholders.
        - A multi-stakeholders participatory approach that takes advantage of the complexities situations that affect sustainable production, marketing and utilization of agricultural commodities.
        - Engage stakeholders beyond the rural communities to ensure their intellectual contribution to innovation and also secure their sense of ownership of research products.
        - Involve policy makers at different levels of governance in research to diagnose problems, facilitate implementation and innovate solutions.
2. **Capacity strengthening of platform facilitators**. We will develop capacity of the platform facilitators to co-lead the Innovation Platforms, linking platform-outcomes to R4D activities being implemented in both districts. Capacity building of facilitators will be done with the help of a Consultant (Per Hillibur) and or a Facilitating Consultancy firm with track record. This process will focus on both stakeholder champions and facilitators selected from the R4D team and partners. In year 1 of this particular action, we seek to develop both within team and local/resident capacity of partners to ensure, continual presence of facilitation ability at the action sites and for sustainability of the process when the consultancy ends.

The linkages between the action research cycles and the innovation platforms are summarized below.

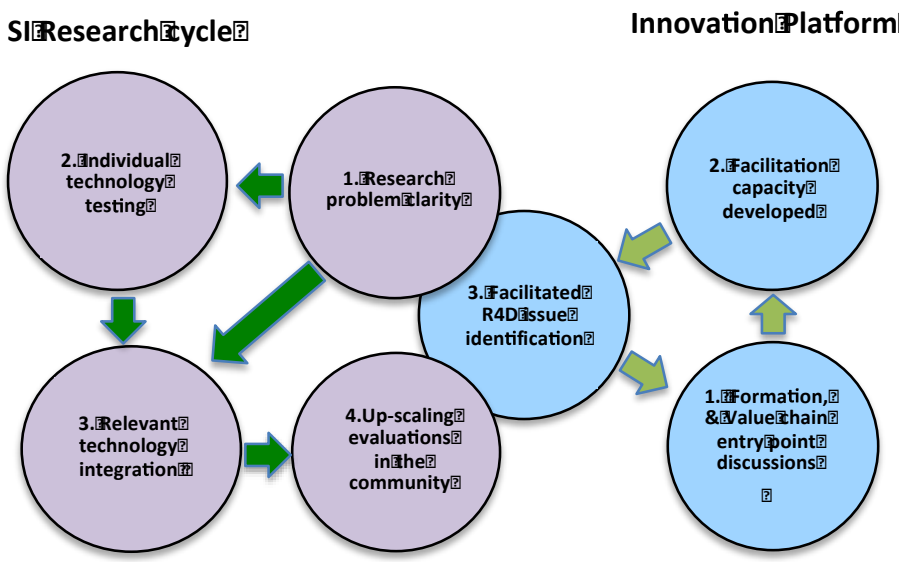


Figure 3. Proposed WP implementation for the 2013-2014 cropping season.

Research activities are being conducted in a four stage process that provides for exploration, validation of technologies and lesson learning; while the Innovation Platform is being conducted in a three stage iterative process that informs the R4D process by clarifying issues for research and other interventions needed to improve functionality of targeted value chains. This is a modification of the two-stage process described by Adekunle and Funtabi (2012)[29] that encompasses clarification of issues for R4D as well as areas for improvement in the innovation systems. This Innovation Platform will be managed by ICRISAT / CIMMYT/ICRAF and ARI- Hombolo teams.

Subtask 5.1.2. Establishment of the nutrition and food safety innovation platforms. Increased agricultural productivity can contribute to nutrition outcomes. However, to deliver nutrition outcomes, R4D investments should include complementary strengthening of livelihoods capital assets such as human capital (especially nutrition education and gender issues), social capital (social participatory processes and gender parity) and finance[30].
We will use the Innovation Platform approach to understudy how best to improve household nutrition and food safety (socio-economic) intensification efforts, particularly, child and maternal nutrition. The food safety work shall focus on how to reduce aflatoxin contamination in food products at all levels including households. The nutrition work will focus on use of complementary feeding based on aflatoxin free cereals and legumes. We shall establish one platform for both districts but with R4D activities in both districts at pilot villages that are also Tuboreshe Chakula and NAFAKA Sites. R4D and capacity strengthening activities will be undertaken as described under WP4 but informed by outcomes from the Innovation Platforms. In order improve potential for R4D impact and lesson learning, the Innovation Platform will be informed by community level meetings that elaborate progress, opportunities and challenges of WP4 implementation. This platform will be managed by ICRISAT in partnership with Sokoine University of Agriculture and Tuboreshe Chakula.
Key activities to be implemented under this task will include but are not limited to the following:

1. Elaboration of critical dietary entry points for R4D interventions via learning meetings. At least two meetings will be held involving critical stakeholders. This particular activity will

[29] Adekunle, A.A. and Fatunbi, A.O. 2012. Approaches for Setting-up Multi-Stakeholder Platforms for Agricultural Research and Development. World Applied Sciences Journal 16: 981-988.

[30] Berti, P.R. Julia Krasevec, J. and FitzGerald, S. 2004. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. Public Health Nutrition: 7: 599–609.

build on efforts by Tuboreshe Chakula that is working in both districts. Initial membership will include partners already engaged by Tuboreshe Chakula.

2. Building capacity of facilitators who will manage the Innovation Platform at district level.
3. As an additional support, the project will also train community level leaders who will lead activities within their communities in terms of training, and supporting R4D work on nutrition and food safety.

Deliverables for 2014
There are six deliverables under this work package for 2013-2014 i.e. that build on progress in 2012-2013.

1. At least 2 R4D platforms for agricultural productivity enhancement and nutrition and food safety established by end of year 2014.
2. Intervention points R4D and other support interventions for targeted legume, cereal and livestock value chains identified to guide project design through the season and in succeeding years.
3. Critical areas of intervention validated via the R4D platforms to inform integration efforts for crops and livestock.
4. Initial lessons learnt on the underpinnings for integration of technologies under SI efforts for semi arid tropical environments.

6 Work package 6

Work package number	**WP 6**	**Start date or starting event:**			November 2012 to September 2013		
Work package title	Lesson learning, networking and coordination						
Activity Type	Action research type, participatory and promotional action						
Target areas (Districts-Villages	Chitego	Laikala	Mlali	Moleti	Mvugala		
WP leader	ICRISAT						
Partners	All Partners						
Total budget (USD)	**10,000**						

Relevant Africa Rising Objective: Objective 4 on Monitoring and Evaluation
Key intervention areas: This WP will speak to the management, coordination, as well as lesson capture during implementation for up and out scaling purposes.

Description of work

Task 6.1. Communication of project activities to wider stakeholders
In 2012-2013 the team drafted a communication strategy to guide communication activities. We will deploy this communication strategy (Appendix 2) as well as draft a dissemination framework as the project enters its third year and for the year where this will be a key activity. During implementation we will further clarify on the different communication and dissemination products and approaches to be used.

Task. 7.2 Networking and coordination. The project will be coordinated by ICRISAT but respective leaders will lead all work packages. The action is underpinned by the need to share lessons across the partners in implementing districts and with other Africa RISING programme actors. Through this WP we will work with the other partners to develop an online repository for information, publications and

documents form the project. The site will establish links with other relevant sites across the Africa RISING programme. In addition, publications and other outputs from this Action will be made available through the site. A discussion platform and information interphase will also be established to improve information.

Task. 7.3 Lessons learning. A lesson learning workshop involving project partners will be held at the end of the year to identify lessons, and emerging issues from the project and how to sustain the key findings and partnerships built during the development and implementation of the project. It is estimated that about 25 participants will attend the workshop.

Deliverables (brief description and month of delivery)

1. Complete and tested dissemination framework to guide out-scaling activities.
2. Lessons learning workshops held to inform project thrusts for the next year.
3. Diverse communication products developed and used to communicate to various project stakeholders.

7 Expected Impacts and Outcomes

7.1 Development impacts

7.1.1 Development impacts

1. **Improved resilience and productivity of agricultural systems**. The outcomes of our intervention will in the long run improve overall farm and land productivity (greater returns to investments, labour productivity and per unit outputs) in target areas of operation leading to more resilient and robust agro-ecologies.
2. **Improved food and nutrition security**. Improvement in food and nutrition security in target areas thus improving prospects for higher quality of life and in general improved livelihoods. Project outputs will contribute to reduced food contamination by aflatoxin and improve access to micronutrients and overall protein budget leading to healthier communities.
3. **Improved household incomes**. By adopting these legumes, farm households will expand their scope for income generation through sales of farm produce. This will be used to support other livelihood strategies of farm households.
4. **Impacts on gender**. In general women produce up to 80 % of basic food for household consumption and sale in most areas of sub- Saharan Africa. Gender inequalities in access to agricultural inputs disadvantage women. Additionally, women routinely have less access to agricultural extension than their male counterparts. We will address these issues and others by targeting interventions to women and other disadvantaged groups. Our aim is to improve access to new knowledge and innovations/ technologies by women by at least 45% as a minimum threshold in target areas. A gender analysis of the status quo will guide project R4D.
5. **Environment sustainability**. This project aims at reducing the negative consequences of poor land use in agriculture. The project will address this via innovations that reduce soil erosion, improve soil fertility management, and improve land use by the agro-pastoral communities through promotion of local but robust pastures. This way the project will secure in the medium to long term improved crop and animal productivity while minimizing the negative effects of poor agricultural practices.

7.1.2 Intermediate development outcomes (IDOs)

These IDOs will be delivered within the medium term (3-5 years) strengthening R4D systems and laying a foundation for sustainable intensification such as:

1. **Research systems strengthened**. This project involves a team of scientists drawn from international and national agencies working with local development agencies to test a number of sustainable productivity enhancing innovations. Through this approach, the capacity of Semi-arid research organisations in Tanzania will be enhanced for undertaking R4D that sustainable increased productivity of their very vulnerable communities.
2. **Sustainable intensification innovations available.** The team will generate a number of innovation packages tested and ready for up and out scaling to increase productivity of semi-arid zones in Tanzania and or similar agro-ecologies.

7.2 Research outputs and outcomes

7.2.1 Main research outputs

1. **Capacity development of communities**. We have engaged three graduate students but will include others as the project develops. Farm households have in year one been taught seed production but more will be trained in subsequent years. Farmers will also be trained on post harvest management, aflatoxin and agronomy of legumes and cereals. We will also build capacity of ARI Hombolo and Selian ARI in diagnostics for long-term management of aflatoxin.
2. **R4D team engaged**. In year 1, we established collaboration with DAICOs, and community leaderships in Kongwa and Kiteto. We also established partnerships with relevant FtF projects such as NAFAKA, Tuboreshe Chakula. We also engaged strategic partners such as Sokoine University and Pasture Research Institute as well as University of Dodoma to support our R&D efforts. We have also partnered with IITA Aflatoxin team operating in Babati. These partnerships will continue in 2013-2016.
3. **Knowledge generated and shared**. This project is entering year 2 of implementation. We generated data that has informed planning for further experimentation. This year we envisage the drafting of at least 3 manuscripts at the end of the 2013-2014.
4. **R4D capacity strengthened**. In 2012-2013 season, we bought rain gauges for monitoring of precipitation. Other equipment we plan to buy this year (2013-2014) includes ELISA readers, centrifuges and other equipment for aflatoxin detection to be based at ARI- Hombolo. ARI-Hombolo as well as DAICO staff where trained in management of participatory variety selection trials in year 1. In year 2, we will further train these staff and others in new techniques and R&D approaches.

7.2.2 Research outcomes

i) **Outcome 1. Increased and stable crop productivity**. Innovations that can increase crop and stabilize yields of maize and dry land cereals by at least 50% for cereals and 40% for legumes in semi-arid zones of Tanzania developed and promoted. This will lead to enhanced opportunities to address food security, nutrition and poverty challenges. This outcome will contribute to the programme objective 2 on integrated systems improvement.

ii) **Outcome 2. Improved land productivity**. This will mainly include greater returns to investments, labour productivity and per unit outputs in target areas of operation leading to more resilient, robust agro-ecologies and productive farming and crop systems of communities in semi-arid zones of Tanzania. This outcome will contribute to the programme objective 2 and 3 on integrated systems improvement and Scaling and delivery respectively.

8 Communication and Dissemination Strategies

8.1 Dissemination strategy

In year 2, the project will develop a dissemination strategy that fits local contexts of target communities. Using the limited Baseline conducted in 2012-2013 season, we will develop a dissemination strategy for various promising technologies and community contexts. The strategy will use a multi-pronged approach including the use of formal interest groups-developmental groups and support groups. A rural growth network model may be used especially where the beneficiaries could be organized into certain type of groupings for collective action by the project.

8.2 Communication strategy

A communication strategy developed, as part of project activities with the following key components will be further developed and deployed (Appendix 2. It will elucidate, the aims of the strategy, target audiences, the broad plan of action, thrust areas of communication, media strategies and communication products. The strategy will also describe how to create a network for change through the target communities to enable sharing of ideas, experiences and communication materials/ products. This activity will be done with support of Africa RISING communication Officer.

9 Monitoring and evaluations

The monitoring and evaluation strategy (M&E) will address issues of compliance, progress monitoring and learning within the project and with other actors. The project theory of change has been developed to guide M&E and learning processes (Appendix 3). Additionally the project log frame will be used for compliance monitoring through the life of the project (Appendix 4). Specifically, the M&E framework will assure, (i) Continued project relevance to outcomes, (ii) Project quality by assessing adaptive competencies and resulting outcomes of performance, (iii) Capacity building for better M&E and learning, (iv) Sustainability by reviewing project continuity and impact logical flow pathways. The M&E strategy will include: (i) an overall results framework that describes various levels of project results and processes from inputs to outcome level; (ii) the M&E procedure for various components of the results framework such as indicators, tools and approaches, data collection and sequencing (annual, mid-term and end of project reviews), information management (iii) Data analysis and qualitative assessments; (iv) Team guidance and mentoring. M&E will be performed by project management team or and IFPRI for evaluations. Participatory M&E will form part of the knowledge management strategy of the project in which partners will reflect on project execution and draw lessons for redesign and steering.

10 Project Budget

Table 1. Summary Budget.
For details see detailed budget below in appendix 5.

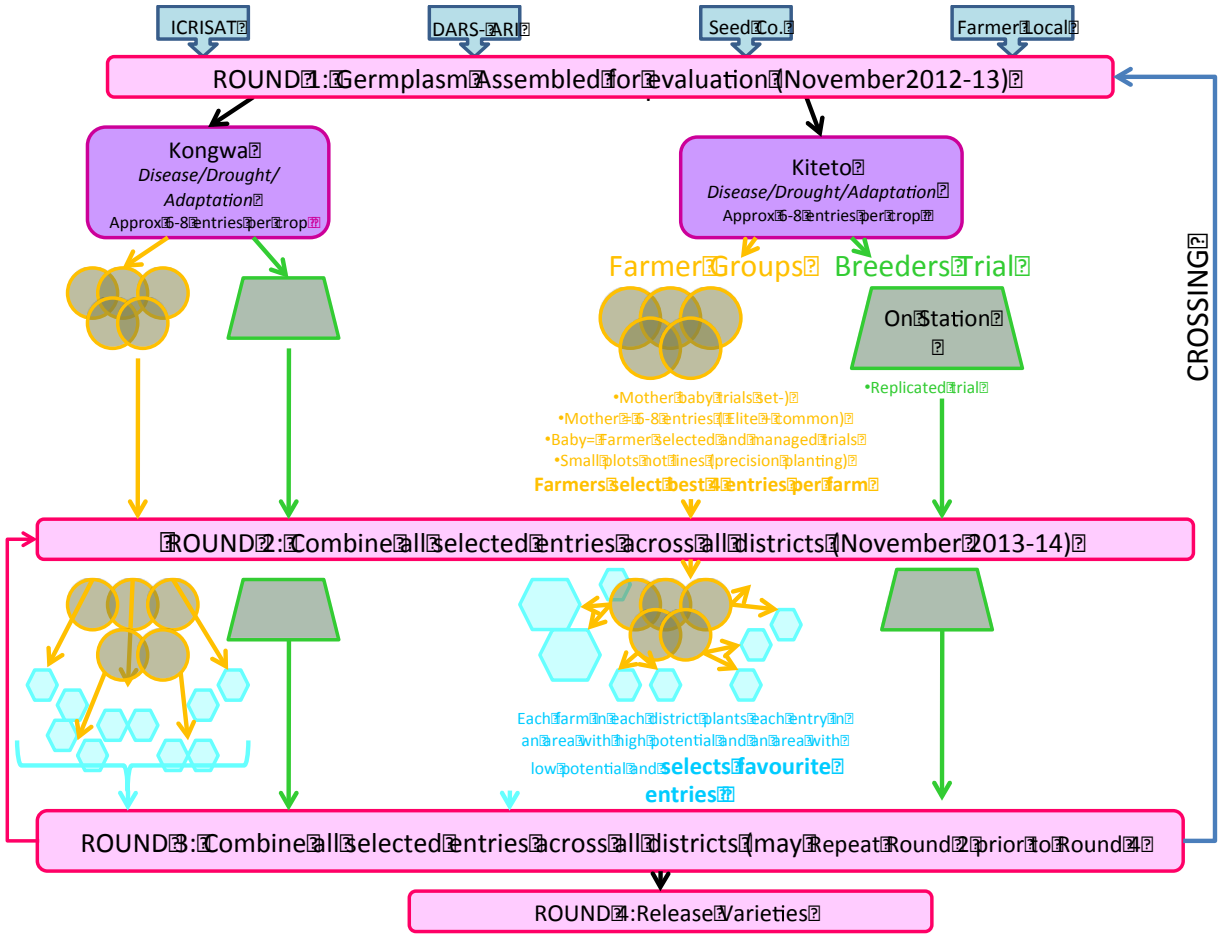
Budget line	Cost line summaries	Cost USD
1. Research		
WP 1	On-farm evaluations	128,680
WP 2	Integrated soil fertility and water management	161,000
WP 3	Crop livestock integration	60,000
WP 4	Improving availability and safety of food	60,000
WP 5	Innovation Platform	94,020
WP 6	Lesson learning and coordination	10,000
Total		**513,700**
2. Staffing costs		**132,362**
3. Travels		**17,005**
4. Overheads		
1. ICRISAT	15%+5% pass through	61762.55
2. ICRAF	15% less pass through	22648
3. CIMMYT	12% less pass through	6625
4. ARI- Hombolo	15% less pass through	5898
Subtotal		**96,934**
Grand total		**760,001**

Table 2. Distribution of funds among partners and by project thrusts

Institution	Research, coordination, Travel	Human resource	Total	Overhead	Grand total	% Distribution
ICRISAT	226,730	59,362	286,092	61,763	347,855	46
ICRAF	183,475	43,000	226,475	22,648	249,123	33
CIMMYT	48,250	18,000	66,250	6,625	72,875	10
ARI Hombolo	72,250	12,000	84,250	5,898	90,148	12
Totals	**530,705**	**132,362**	**663,067**	**96,934**	**760,001**	**100**

11 Appendices

11.1 Appendix 1: Participatory variety selection scheme for development of demand specific improved legumes and cereals



11.2 Appendix 2. Project Communication Strategy

PART 1. ABOUT THIS COMMUNICATION STRATEGY

1. Introduction

This Project is among the two being supported by Africa RISING in East and Southern Africa, as part of USAID's Feed the Future (FtF) initiatives to combat hunger and lack of food security in Africa. The Africa RISING programme led by IITA is implementing research along with other research agencies to sustainably intensify household food, cash crop and livestock production as the eco-friendly approach to increase productivity of already strained environments. The Project and Programme engage diverse stakeholders with varying communication interests and need. This document outlines a Communication Strategy for meeting diverse communication interests of the projects stakeholders.

1.1 Communication management plan

This plan defines the following key elements of communication that will be conducted by the project team and supported by the Africa RISING Communication Officer:

1. Type(s) of information that will be communicated and how that will be done;
2. Frequency of project communications both formal and informal;
3. Responsibilities for communicating;
4. Management of sensitive information;
5. The flow of project communications.

1.2 Purpose of the management plan

To identify planned communications and methods of exchanging information to stakeholders within the projects outside of the project implementation. This document will be reviewed from time to time to ensure that it remains live and mainstreamed to the Africa RISING Communication Strategy.

PART 2: KEY AUDIENCES THEIR NEED AND RESPONSIBILITIES

2 Audiences, communication roles and responsibilities

2.2 Project team

The project team comprises scientists who are implementing the project as well as strategic partners engaged in implementation. The scientists comprise the core implementation team, whilst strategic partners comprise the associate partners needed for successful implementation. These will be involved in implementation variously and may also be users of the project products. They will generate most of the communication products and in large measure, be responsible for communicating their knowledge to various stakeholders.

2.3 Programme secretariat

Africa RISING Programme is coordinated overall by the IITA, with three sub–regional areas of operation i.e. Ethiopian Highlands, East and southern Africa and West Africa. For purposes of this strategy we will communicate to the East and Southern Africa sub-regional coordination office as well as with the overall Secretariat. Communication products for both offices will largely comprise project contracting, monitoring and evaluation reports, progress reports (technical and financial) as well as regular updates of state of the project and other information deemed necessary for successful implementation. The Secretariat will be held responsible for wider communication to regional and global audiences as well as with the development partners. In this project, the Secretariat will form the second layer of communication for scaling up and out of new knowledge.

2.4 External stakeholders

These comprise stakeholders who are categorized either as users of project products and knowledge, the wider publics, development partners, government and private sector agencies. These stakeholders are critical for scaling-up and out of innovations. Communication products will be designed to target delivery of various types of identified and emerging information and knowledge needs. In this project external partners will be engaged in uptake and use of communication and research for development products. External partners will be invited to open days, receive various media products about the project, participate in dissemination meetings etc. they will also form the base from which the project learns about the potential outcomes and areas for improvement.

2.4 Stakeholder communication interests

In order to identify all project stakeholders to be communicated with, as well as their communication needs and appropriate media, a stakeholder communication register will be generated and updated regularly. Communications will occur in accordance with the communication matrix as specified by stakeholder communication requirements.

Part 3: CHANNELS

3.1 Internal communication

The project will use a wide range of communication channels for its internal use. Internal communication will be conducted in any of the following ways

3.1.1 Informal communication

Largely done by email and telephone between project members and in some case stakeholders. This approach will be used to get quick information and updates on any project area

3.1.2 Formal communication

This channel will be used to formally communicate official project information to partners, the Africa RISING Secretariat or stakeholders. A combination of web-based tools and approaches that support VOIP such as SKYPE, Go to Meeting etc; email and letters will be used as appropriate. Partners will use their Institutional letterheads but when communicating about Africa RISING to external stakeholders, the appropriate Africa RISING branding will be used.

3.1.3 Status meetings

This will be held once every year involving all team members within the action site. We will involve critical stakeholders to review progress over the cropping season.

3.1.4 Status reports

Each WP leader will sub-submit progress reports in the first week of the last month of each quarter to allow compilation of the reports for onward transmission to the Africa RISING secretariat.

Internal communication will be guided by the communication matrix below.

Internal communication Matrix

Type of Communication	Audience	Frequency	Responsibility	Purpose	Media
Technical reports	Team	Quarterly	WP leaders	Progress monitoring	Email & Phone
Financial reports	Team	Quarterly	WP leaders	Progress	

				monitoring	
R&D queries/Planning	Team	Regularly	Team	Implementation	

3.2. External communication

This will guide sharing of information to other stakeholders not within the project or directly involved in project implementation. The summary of the actions to be done are presented in the communication matrix below

Project Oversight					
Type of Communication	**Audience**	**Frequency**	**Responsibility**	**Purpose**	**Media**
Technical & Finance reports	ICRISAT HQ	Quarterly	PI	Report submission	Email
Technical & Finance reports	Secretariat	Quarterly	PI	Progress monitoring	Email
Monitoring indicators	Secretariat/FtF	Quarterly	PI	Progress monitoring	Web-based and Email
Public communication					
Type of Communication	**Audience**	**Frequency**	**Responsibility**	**Purpose**	**Media**
New technologies	Farmers	2/ village	WP team	Dissemination	Field days
New knowledge	Farmers,	2/ village	WP team	Training	Demos.
New knowledge	Scientists	1 district	WP team	Training	Workshops
Mass media	Wider publics	<2 per year	WP team	Awareness	Local and national mass media
Success stories	Wider publics	2 quarterly	WP team	Promotion	Web-based and Email
Policy briefs	Government	2 per year	WP team	Promotion	Print
Scientific publications	Scientists	Varied	WP team	Dissemination	Journals and conferences

Part 4: SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis

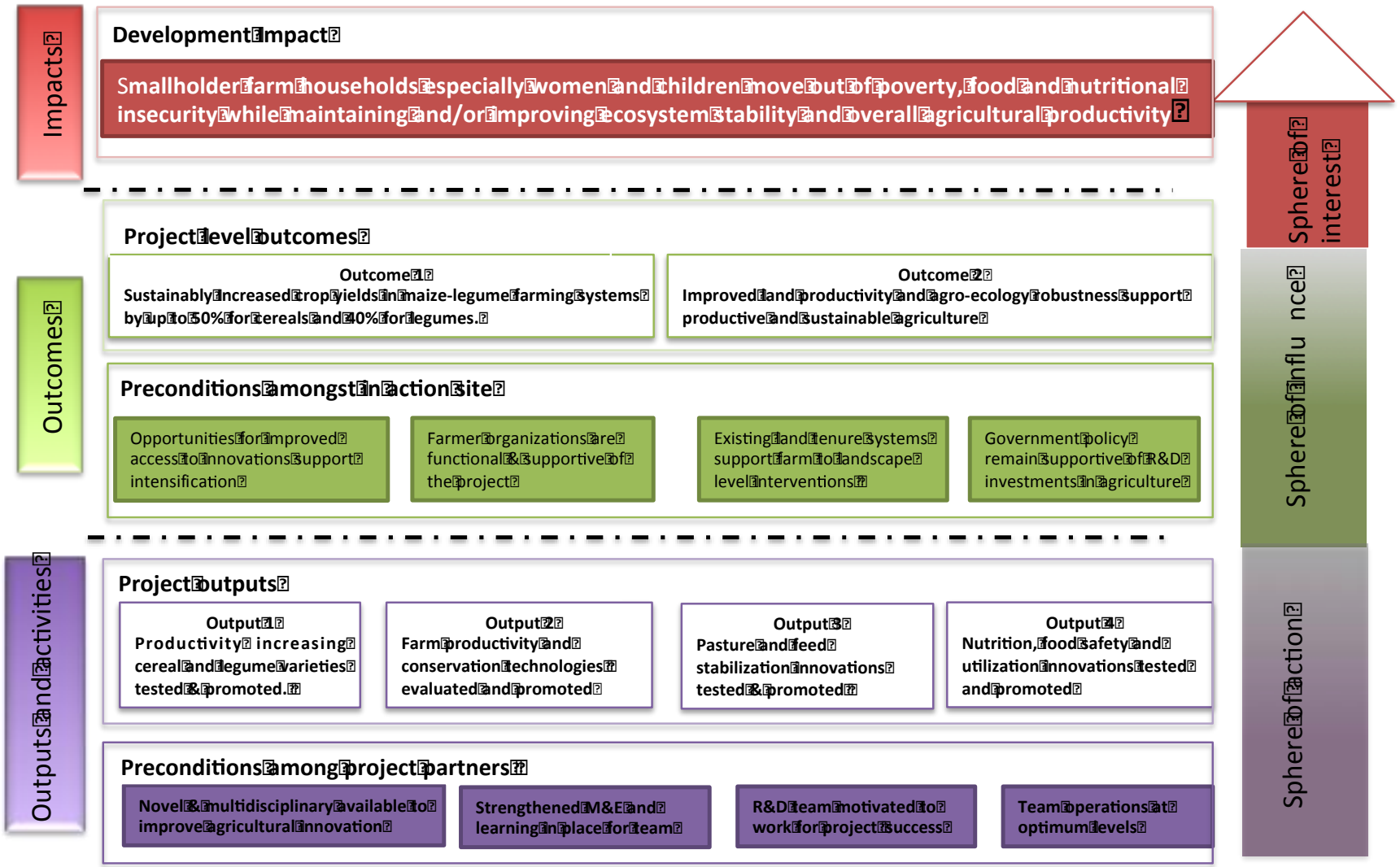
4.1 Communication challenges

1. Due to limited project funds and capacities the project may not be able to reach out to all critical stakeholders in the frequency and manner possible. This may curtail knowledge dissemination efforts.
2. Due to the technical background of the project implementation team some of the communication products may not be best suited for wider publics, leading to miss-and or limited communication.

4.2 Mitigation strategies

1. The project will strive to be partner to existing forums such as Partnership for Aflatoxin Control in Africa (PACA) for dissemination of Aflatoxin control, Tanzania national efforts to combart Aflatoxin contamination, National farmers Days (*nane nane*) etc where R&D actors, stakeholder and government actors discuss how to promote agricultural productivity sustainability and make a difference for farmers and communities in Tanzania.
2. Linkage with and use of diverse communication portals to increase the reach of the project such as partner websites, programme websites, linkages to CRP activities will be done. These partners promote communication and dialogue on agricultural productivity sustainability issues. They will be engaged to complement other efforts in the country.
3. The Team will draw on the expertise of the Africa RISING Communication Officer as well as Partner Institutional Communication Officers, including the training of project team members to develop and or deploy suitable communication products.

11.3 Appendix 3. Project Theory of Change



11.4 Appendix 4. Logical frame work

Objectives-hierarchy	Objectively Verifiable Indicators	Means/Source of Verification	Important Assumptions
Provide pathways out of **hunger** and **poverty** for small holder families through sustainably intensified farming systems that sufficiently improve **food, nutrition, and income security**, particularly for **women and children,** and conserve or enhance the **natural resource** base.	1. Agriculture value added per person	Programme and project monitoring reports	Political stability
	2. Incomes of rural households disaggregated by sex and income quintile		Adequate country ownership of Africa RISING
	3. Prevalence of stunted children	Programme *ex-post* evaluation report	Land tenure allows for interventions at landscape level
	4. Prevalence of wasted children		
	5. Prevalence of underweight women.	National Poverty Monitoring Surveys	The Government of Tanzania continues to prioritize investments in Agriculture
	6. Yield per unit area of crop planted.	Famine Early Warning System monitoring reports	
	7. Incomes generated per household.	National household expenditure surveys	
	8. Innovations adopted as packages or singly for increasing productivity.	National population and health services survey reports	
Objective 1: To identify and evaluate demand-driven options for sustainable intensification that contributes to rural poverty alleviation, improved nutrition and equity and ecosystem stability.	1. Integrated innovations increase production and / or improve productivity by at least 25% in a sustainable manner for targeted households at the Africa RISING research sites by December 2016.	Programme M&E reports, project reports, national reports of performance of the agriculture sector for central Tanzania.	1. Adoption rates for any innovation (combinations of technologies and management practices and knowledge) are enhanced by targeting on-demand from stakeholders and capacities of potential adopters.
Objective 2: To evaluate, document and share experiences with approaches for delivering and integrating innovation for sustainable intensification in a way that will promote their uptake beyond the Africa RISING action research sites.	2a. The aggregated impact of these farming practices at the household level contributes to an improved understanding of ecosystem stability at the landscape level with at least 30% of farm household reporting benefits from programme actions by 2016		3. Innovations with components that mutually reinforce whole farm performance/productivity produce greater and more sustained benefits than the joint adoption of equally effective single purpose technologies and practices.
	2b. At least new 2 R4D platforms for crops and 1 for livestock established in each district by December 2014 and used to support community engagement in innovation and adoption through action research.		

Objective 3: To create opportunities for smallholder farm households, within Africa RISING action research sites, to move out of poverty and improve their nutritional status – especially of young children and mothers – while maintaining or improving ecosystem stability.	3. Wider dissemination of integrated innovations for SI leads to similar impacts beyond the Africa RISING action research sites as evidenced by spill over to neighbouring villages by the end of 2017.		4. Effective targeting of innovations also reduces the negative impacts of trade-offs between farm productivity and environmental sustainability and helps to identify potential "win-win" options for SI.
Objective 4: To facilitate partner-led dissemination of integrated innovations for sustainable intensification beyond the Africa RISING action research sites.	4. Wider adoption of innovations identified and tested by the programme's outputs within the Africa RISING action research sites enhances livelihoods through increased agricultural output 30-50% yield increase), income diversity (various legumes and cereals livestock produced and sold), reduced vulnerability to adverse environmental and economic challenges and improved nutrition and welfare (improved child growth indices); especially of young children and mothers by December 2017.		5. The adoption of innovations that lead to SI is affected by the sequence in which the component technologies, practices and knowledge are integrated and applied.
	5. The development community initiates programmes, based on the knowledge tools and innovations developed and promoted by Africa RISING, that are directed at developmental goals that are consistent with the Africa RISING programme purpose.		5. A research approach based on targeting and evaluating SI-related innovations, in context, increases the relevance of findings from action research sites and enhances their scalability to similar strata elsewhere (i.e. to similar development domains and households typologies in other locations).
	Milestones		
Activity 1. Socio-economic and Biophysical baseline studies undertaken at Programme and Project levels to characterise agro-ecologies, farming systems and production resources and households of target communities by December 2013.	1.1. Baselines on the level and sources of post harvest losses and food safety contamination along selected crop market/value chains by end of by December 2013.	IFPRI programme wide baseline report, Farming Systems Analysis Report at Programme level, Kongwa- Kiteto Project progress reports for the 2012-2013	Government budget and policy support for agriculture remains supportive
	1.2 Biophysical characterisation of action sites to underpin R&D interventions by December 2013.		Region remains political stable and safe to conduct research with communities
	1.3. Farming systems characterized to guide		

	development of intensification approaches by December 2013.		
	1.4. Development domains of both districts appropriately mapped to guide location of the intervention and the innovation platform by December 2013.		Communities remain supportive of development efforts and continue to engage with development partners
	1.5. Community and selected commodity value chains analysis and baselines completed by December 2013.		
Activity 2. Evaluate and identify cereals and legume varieties that meet farmer and market needs through on-farm and market participatory methods by December 2014	2.1. At least 10 varieties crop varieties for cereals (maize, sorghum) and legumes (groundnuts, pigeonpea and Bambara nuts) evaluated on-farm in both districts annually for first two years of project life (2012-2014).	Kongwa Kiteto-Project progress, Partner annual reports for the 2012-2013	Other complementary development agencies and partner continue to invest and operate at appropriate levels that support agriculture led growth of the economies of target countries
	2.2. At least two best adapted farmer-preferred groundnuts varieties identified and validated for Kongwa and Kiteto by December 2013.	Research publications from the project and project annual and quarterly progress reports	Communities remain receptive of new innovations and engage with R&D teams in innovation processes
	2.3. At least two best adapted farmer-preferred pigeonpea varieties identified and validated for Kongwa and Kiteto by December 2013.		Agro-ecological and meteorological conditions remain conducive for appropriate testing.
	2.4. At least two adapted farmer-preferred maize varieties identified and validated for Kongwa and Kiteto by December 2013.		National partners continue providing adequate country ownership and support for smooth implementation of Africa RISING interventions.
	2.5. At least two adapted farmer-preferred sorghum varieties identified and validated for Kongwa and Kiteto by December 2014.		
	2.6. At least two adapted farmer-preferred Bambara nut varieties identified and validated for Kongwa and Kiteto by December 2014.		

Activity 3. Evaluation of soil fertility and water management options for integrated soil erosion, fertility and water management	3.1. Experiments to test appropriate application rates of N&P fertilizers and cattle manure initiated by December 2012.	Kongwa Kiteto-Project progress, Partner annual reports for the 2012-2013	Communities remain receptive of new innovations and engage with R&D teams in innovation processes.
	3.2. Testing of options for spatial integration of pigeonpea and maize to improve soil fertility and crops yields initiated by December 2013.	Research publications from the project and quarterly and annual progress reports.	
	3.3. Soil and water conservation technologies tested in both districts by December 2013.		
	3.4. Nutritional quality of indigenous forage and pasture species determined to guide the selection of appropriate species for integrated crop and pasture management systems established by December 2013.		
	3.5. Validated options for integration of promising technologies to develop guidelines for inorganic fertilizer and cattle manure application by farmers completed by December 2014 for up scaling purposes in subsequent years.		
	3.6. Validated options for spatial integration of pigeonpea and maize to improve soil fertility and crops yields completed by December 2014. Other legumes to be considered in subsequent years based on IP contexts.		Agro-ecological and meteorological conditions remain conducive for appropriate testing
	3.7. Options for integration of soil and water conservation technologies validated for up-and out scaling by December 2014.		
	3.8 Capacity of farmers in livestock and poultry feeds management strengthened to support farming system integration and increased productivity by December 2014.		

	3.9. Appropriate fodder trees and shrubs and their crop/pasture integration options for maize-based farming systems identified and validated by December 2014 for up- scaling in subsequent years		National partners continue providing adequate country ownership and support for smooth implementation of Africa Rising interventions
	3.10. Guidelines on appropriate sources and use of P for maize and pigeonpea production in targeted sites evaluated and promoted for scaling up and out by December 2015.		
Activity 4. Integrated livestock and poultry management for productivity enhancement	4.1. Quantity and quality of the grazing land pasture resources determined to guide research targeting for improved management completed by December 2013.	Kongwa Kiteto-Project progress, Partner annual reports for the 2012-2013	Agro-ecological and meteorological conditions remain conducive for appropriate testing
	4.2. Local institutions and their roles in grazing land management documented to guide future interventions for development of appropriate community based grazing systems by December 2014.	Research publications from the project	Communities remain receptive of new innovations and engage with R&D teams in innovation processes
	4.3. A costed framework for up scaling evaluated technologies generated and used to guide up- and out scaling efforts in subsequent years completed by December 2014.		Farmer organisations and institutions are functional and committed to the project action
	4.4 Option for improving free-range poultry production tested and validated by December 2014 for up and out scaling in subsequent years.		
Activity 5. Improve food and nutrition for home and market needs	5.1. Aflatoxin prevalence in selected cereal and legume value chains mapped to guide interventions by October 2013.	Kongwa Kiteto-Project progress, Partner annual reports for the 2012-2013 and subsequent years	Farmer organisations and institutions are functional and committed to the project actions
	5.2. Effect of weather changes on *Aspergillus* populations and aflatoxin contamination in targeted crops documented for 2 seasons (2013-2014 and 2014-2015 to guide design of management options in subsequent years.		

	5.3 A gender based analysis of agricultural enterprise in at least two villages of each district to inform gender based implementation nutrition and food security conducted.		
	5.4 Approaches to mitigate food losses, and aflatoxin contamination at households tested and validated for scaling up and out in subsequent years by December 2014.		
	5.5. Aflatoxin hot spots area mapped for targeted intervention by December 2014.	Research publications from the project	National partners continue providing adequate country ownership and support for smooth implementation of Africa Rising interventions
	5.6. 50-80 new farm families in study sites engaged annually in nutrition and food safety drives.		Communities remain receptive of new innovations and engage with R&D teams in innovation processes
	5.7. Appropriate legume/cereal complementary feeding strategies for child and maternal health tested and up scaling by December 2014.		
	5.8. Appropriate legume processing technologies for household levels tested and validated for promotion by December 2014 for up scaling in subsequent years.		
	5.9. At least 10 key farmer leaders per village of target districts trained on post-harvest management of grain to minimize aflatoxin contamination.		
	5.10. A network of partners to support aflatoxin mitigation efforts in the two regions engaged by December 2014.		
	5.11. Critical partners trained (NAFAKA, Tuboreshe Chakula and ARI Hombolo staff) on aflatoxin management and detection by December 2014.		
	5.12. Resident capacity developed in Tanzania at ARI Hombolo and Selian Research Institute to detect aflatoxin in various crops by December 2015.		

Activity 6. Innovation Platforms created in target districts for Commodity and nutrition intensification activities by December 2014	6.1. Selected communities and stakeholders engaged in initial dialogues to establish operational framework or the IP by end of year 2 (December 2014).	Kongwa Kiteto-Project progress, Partner annual reports for the 2012-2013	Communities remain supportive of development efforts and continue to engage with development partners
	6.2 Intervention points for R4D and other support interventions for targeted legume, cereal and livestock value chains identified	Research publications from the project	
	6.3. Innovative community learning and action research based systems initiated for testing and evaluation of various technologies in Kongwa and Kiteto by December 2014.		Government budget and policy support for agriculture remains supportive
	6.4. Results from year 1 and 2 and two shared with IP members By October 2014 and the learning points at IP level used to redesign year 3 of research (2015).		National partners continue providing adequate country ownership and support for smooth implementation of Africa Rising interventions

11.5 Appendix 5. Detailed budget broken down by work packages and activities

Work Package	Summary of activities	Budgeted Cost (USD)
WP 1	**On-farm evaluations**	
	1.1 Cereal trials	
	Task 1.1.1 Maize adaptation trials	10,000
	Task 1.1.1.1 MLN studies	10,000
	Task 1.1.1.2. QPM	10,000
	Task 1.1.3 Pearl millet/sorghum trials	15,000
	Task 1.2 Legumes	
	Task 1.2.1 Pigeonpea	10,000
	Task 1.2.2 Groundnuts	12,000
	Task 1.2.3 Bambara nuts	10,000
	Task 1.3 Vegetables	5,000
	Task 1.4 Seed systems	46,680
Subtotal		**128,680**
WP 2.1	**Soil fertility management**	
	Task 2.1.1 Fertilizer efficiency trials	20,000
	Task 2.1.2 Integrating Mijingu & Tillage interventions	20,000
	Task 2.1.3 Exploring intercropping options	20,000
	Task 2.1.4. Cost benefit analysis	5,000
Subtotal		**65,000**
WP 2.2	**Land and water management**	
	Task 2.2.1 Soil erosion mangemement studies	
	Task 2.2.1.1 Physical barrier for erosion control	20,000
	Task 2.2.1.2 Efficiencyof control technologies	10,000
	Task 2.2.2 Insitu water harvesting technologies	
	Task 2.2.2.1 Farmer training and research activities	25,000
	Task 3.2.3 Cost benefit analysis	5,000
Subtotal		**60,000**
W P 2.3	**Trees for enhancing fodder and crops production**	
	Task 2.3.1 Shelterbelt and/or boundary planting	10,000
	Task 2.3.2 Integrated crop/livestock productivity	15,000
	Task 2.3.3 Cost benefit analysis	5,000
	Community engagement in field days and on-farm	6,000
Subtotal		**36,000**
Subtotal WP 2		**161,000**
WP 3	**Crop livestock integration**	
	Task 3.1 Availability of feed studies	
	Task 3.1.1 Quantity and quality during wet season	20,000

	Task 3..2 Improving grazing area management	
	Task 3.2.1. Role of local institutions studies	10,000
	Task 3.2.2. Improving pasture quality and quantity interventions	10,000
	Task 3.3 Improving poutry production	15,000
	Community engagement in field days and on-farm	5,000
Subtotal		**60,000**
WP 4	**Improving availability and safety of food**	
	Task 4.1 Reducing post harvest losses studies	15,000
	Task 4.2 Food safety studies (mycotoxins)	20,000
	Task 4.3 Improving nutrition	
	Task 4.3.1 Legume consumption studies	10,000
	Task 4.3.2 Processing and utilization of legumes	10,000
	Community engagement in feeding & nutrition trials	5,000
Subtotal		**60,000**
WP 5	**Innovation Platform**	
	5.1 Harnessing R4D platforms	
	Task 5.1. Commodity Value.Chain IP costs	
	Capacity building	16,100
	Operations IP	
	i) Travels R&D team	16,000
	ii) Meeting costs	7,840
	iii) Local IP facilitation costs	5,000
	iv) External Facilitation	15,000
Sub-total		**59,940**
	Task 5.3. Establishment of Nutrition IP	
	Capacity building	10,000
	Operations IP	
	i) Travels R&D team	7,080
	ii) Meeting costs	12,000
	iii) Loca IP facilitation costs	5,000
Sub-total		**34,080**
Grand sub-total		**94,020**
WP 6	**Lesson learning and coordination**	
	Task 7.1 Communication	2,000
	Task 7.2 Networking and coordination	4,000
	Task 7.3 Lesson learning	4,000
Subtotal		**10,000**
Total Research Activities		**513,700**
2. Personnel Costs		

2.1 Senior scientists		
Staff-Time Coordinator	Coordination	24,000
Staff-Time ICRISAT	Research activities	18,000
Staff-Time CIMMYT	Research Activities	18,000
Staff-Time ICRAF	Research Activities	18,000
Staff Time UDOM	Research Actvities	12,000
Staff Time PRC	Research Actvities	5,000
Partner ARI- Hombolo	Research Activities	12,000
Subtotal (A)		**107,000**
2.2 Support staff		
Field Research Officer		6,000
Research Assistants		
WP 1	1	4,000
WP 2,3	2	8,000
WP 4	1	4,000
Driver	1	3,362
Subtotal (B)		**25,362**
Total Personnel		**132,362**
3 Travels		
3.2 Travel regional		5,000
3.3 Travel International		12,005
Subtotal		**17,005**
4. Overheads		
ICRISAT	15%+5% pass through	61762.55
ICRAF	15% less pass through	22648
CIMMYT	15% less pass through	6625
ARI- Hombolo	12% less pass through	5898
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